Experience Points:

Learning, Product Literacy and Game Design

by

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ABSTRACT

Game design and product design are natural partners. They use similar tools. They reach the same users. They even share the same goal: to provide great user experiences.

This thesis asks, "Can game design build better product learning experiences, and if so, how?" It examines the learning situations created by and necessary for product design. It examines the principles of game learning. Then it looks for opportunities to apply game learning principles to product learning situations. The goal is to create engaging and successful product learning experiences, without turning products into games.

This study uses an auto-ethnographic evaluation of a gameplay session as well as participant observation and interviews with gamers to gather qualitative data. That data is sorted with an A(x4) framework and used to create user experience profiles.

The final outcome is a toolkit that identifies areas where game design could improve the design of product user experiences, especially for product learning.

To Jim and Sue Reeves

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ACKNOWLEDGMENTS

I would like to thank the following people: Prasad Boradkar, Elisabeth Gee, Don Herring, John Takamura, Heidi Fischer, Jessica Vasquez, Marty Province, and Lindsay Dreher. This was a long—and frequently frustrating— journey. You listened patiently. You asked pointed questions. You gave feedback. A few times you even swooped in like super heroes and saved the day.

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INTRODUCTION

Problem Statement

The design of new products and services often requires users to learn new technologies, terminologies, behaviors, routines, etc. Designers, aware of this condition, design specific affordances into products to help learning, and users deploy a set of tools like feedback loops for dealing with them.

To me, games do it better. They are designed to be difficult--to provide a steady stream of challenges and apprehension (Knizia, Salen, & Zimmerman, 2004; Schell, 2008). They force players to learn and relearn throughout the user experience (Gee, 2007). Yet their users do not get discouraged. They keep coming back for more challenges and more learning, spending millions of hours and billions of dollars in the process (ESA, 2015).

How do they do it? How do game designers create learning experiences that are both difficult and engaging? My goal with this thesis is to examine this apparent paradox. Then I want to apply what I learn to product design.

Research Topics and Questions

This thesis focuses on the relationship between game design and product design. It has three research goals:

Game Learning and Product Learning

First, I want to identify areas where game design could improve the design of product user experiences, especially product learning. Where do product learning experiences occur? How do games deal with similar learning situations? We will deal with these questions in the Literature Review.

The Experience of Game Learning

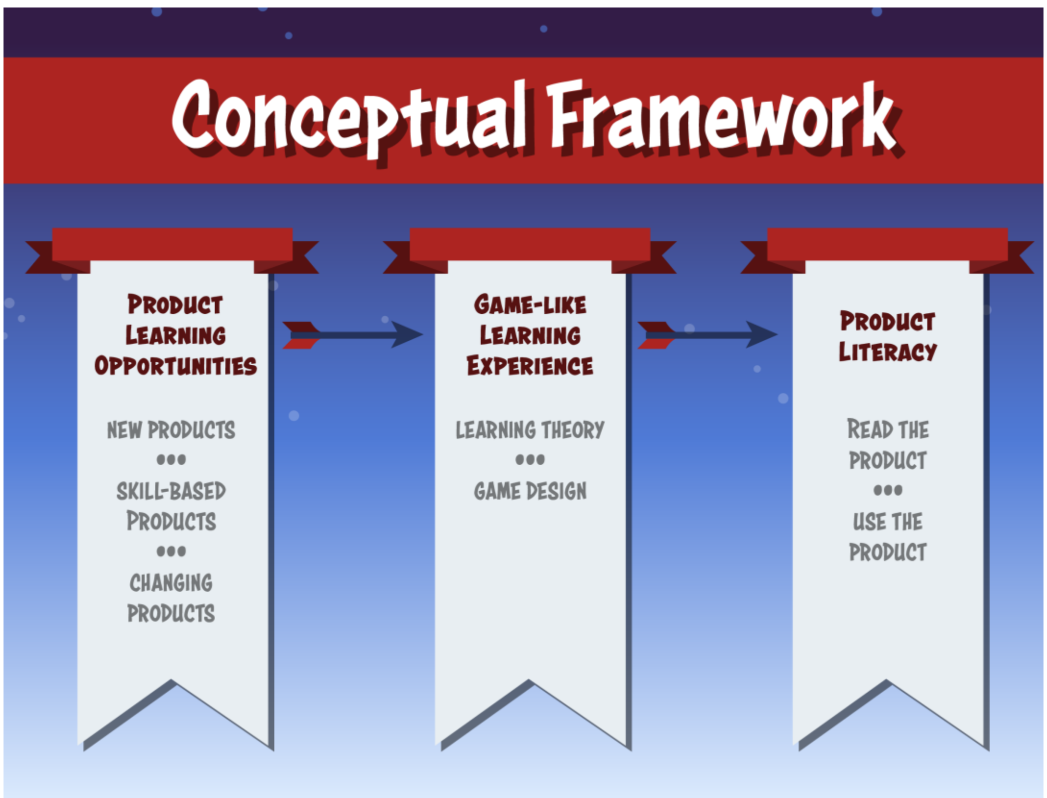
Second, I want to understand what game learning looks like. What do people do when they are learning a game? What engages them? When are they frustrated? When do they feel successful? How does the game shape their experience? I explore answers to these questions through primary research included in the sections titled Research Design, Findings, and Analysis.

Ludomimicry and Learning

Third, I want to develop a toolkit for using game design principles to improve product learning. How can I make product learning more engaging and effective? How can it be more game-like, without actually becoming a game? This will start in the Analysis section and continue through the Discussion.

Conceptual Framework

Figure 1: Conceptual Framework



Significance

Gaming is immensely popular. 60% of Americans are regular gamers, and we spend nearly 2.4 billion hours per week playing games (ESA, 2015). By itself, such a large investment of time should demand our attention.

But beyond the sheer weight of numbers, there is a subtler argument based on how we learn and how we are developing as a culture. Game designer and researcher Eric Zimmerman believes that games and game design reflect a new type of literacy (Zimmerman, 2008). "There is an emerging set of skills and competencies," he argues, and "a set of new ideas and practices that are going to be increasingly a part of what it means to be literate in the coming century." These concepts, which he describes as "systems, play, and design," are necessary to navigate a world of complex communities and connections.

Just as traditional literacy allows us to read and write, “systems literacy” (Zimmerman, 2008) allows us to observe and manipulate the interconnected relationships in a system. Play allows us to imagine creative possibilities. And design empowers us to build new systems of our own.

Because games engage all of these skills, and because they are so widely popular, Zimmerman believes that they are ideally suited to help us learn to navigate our emerging interconnected culture: "Games and game design are one promising approach, making use of a cultural form that is wildly popular and wildly varied, both incredibly ancient and strikingly contemporary. And intrinsically playful as well." (Zimmerman, 2008)

As product designers, we have three powerful incentives to collaborate with game design. First, gaming literacy is already emerging and it makes sense for us to add it to our tool kit. Second, as the people who create many of the complex tools and systems that engage gaming literacy without actually being games, we are in a position to shape gaming literacy as it emerges into the real world.

The third reason lies within design itself. As a complex, interconnected, people-centered system, design already demands gaming literacy. Not all of us are gamers, but every user-centered designer is already familiar with systems, play, and of course, design.

Viewpoint, Scope and Limitations

This thesis is a product evaluation. But instead of assessing a consumer product, I will evaluate video games. I am particularly interested in the learning principles that are built into game design, and that is where I shall focus my attention.

My goal is to improve the practice of product design by borrowing and applying specific aspects of game design. In my examination of games, game learning and game design, I will be looking for means by which to bring them into the product design studio.

The primary research will use a qualitative approach. This research is exploratory in nature, and involves collection of observational and interview data, a search for patterns and recommendations for product design.

Chapter 2

LITERATURE REVIEW

Here is the Plan

I have three goals in this section.

First, I will establish the need for good learning design. Design is a discipline that introduces change into the world, and change demands new learning. Every time we introduce a new product, we ask users to learn how it works and how it fits into their world. Every time an existing product changes, updates or ages, it leads to a new learning experience.

These opportunities pop up whether we plan for them or not. Such occasions are frequent in design and it is not possible to address them all. But we can build products that facilitate learning and make it a rewarding part of the user experience.

Second, I will to propose a partnership between game design and product design. Unlike most products, games are intentionally difficult. They constantly require new learning from their users. James Gee and Elisabeth Hayes, education and literacy researchers at Arizona State University describe it this way: "Video games are all about problem solving and the sorts of persistence, ability to cope with failure, and strategic thinking that problem-solving requires." (Gee & Hayes, 2010)

Persistence, coping with failure and strategic thinking are great qualities to find in a customer, especially when they are learning modern, skill-based electronic products, like smart phones or digital cameras. Game designers know how cultivate those qualities. They also use many of the same tools that product designers use, like affordances, feedback, and experimental learning. It would be relatively simple to adopt some of the learning principles of game design into product design. And it could create some great product user experiences.

Finally, I will ask what a game design/product design partnership might look like. I will compare game-inspired design to biomimicry, another design hybrid, and examine the challenge of using game design principles without making a game-like product.

The active Personal Voice

Throughout this thesis, I refer to myself directly.

In traditional research writing, authors mask their identity (Hyland, 2002; O'Leary, 2010). They replace personal pronouns, like "I" and "me" with anonymous titles like "the author" or "the researcher." Some individual writers may go a step further and refer to themselves as a team of people, using "researchers" instead "the researcher" (Plattner, 2015). To further avoid referring to themselves, traditional writers may also use the passive voice. "We conducted the survey in a controlled setting," becomes, "The survey was conducted in a controlled setting," (American Psychological Association, 2010). The person who conducted the survey disappears entirely.

The goal is to provide an objective tone for the discussion (Hyland, 2002; O'Leary, 2010; Raymond, 1993). Along with their identity, the authors are demonstrating that they have set aside their personal opinions, in order to suggest that the research is not "tainted with personal bias and subjectivities," (O'Leary, 2010)

The impersonal, passive voice can be effective. James Raymond writes that "the appearance of objectivity is a persuasive move," and in certain cases it "adds power to the argument," (Raymond, 1993). Ken Hyland argues that "The words [researchers] choose must present their ideas in ways that make most sense to their readers, and part of this involves adopting an appropriate identity,"(Hyland, 2002). For traditional writers and readers, especially those in the physical sciences, the appropriate identity is no identity at all. But the impersonal, passive voice is not the right choice for this thesis.

First, there is a question of attribution. When I make a decision or arrive at a conclusion, how do I ensure that readers know where it originated? To avoid confusion, the 6th edition of the American Psychological Association (APA) style guide recommends that writers "use a personal pronoun rather than the third person when describing steps taken in [their] experiment," (American Psychological Association, 2010).

Instead of saying, "The authors reviewed the literature," writers should say "We reviewed the literature," (American Psychological Association, 2010). Or, in my case, I should say "*I* reviewed the literature," since I am a single researcher, instead of a team. This way I prevent inappropriate or confusing claims about who performed the research.

But I did not choose this voice simply to avoid confusion. I also chose it because it matches the existing literature in design research, material culture studies, gaming research and psychology. Nearly every book in the bibliography of this thesis uses the active personal voice (Csikszentmihalyi, 1975; Gee, 2007; Gee & Hayes, 2010; Gibson, 2014; McGonigal, 2011; Norman, 1988, 2007; Salen & Zimmerman, 2004; Verbeek, 2005). Many of the journal articles do too. The conversation about games, learning and product design is ongoing and I will join it on its own terms.

Experiences, Phenomenology and Material Culture

Games are meant to be played, or in design terms, they are meant to be *experienced*. “A game’s space of possibility is defined as more than a mathematical entity,” write Katie Salen and Eric Zimmerman. “It is a space in which a player’s emotions and sense of desire undergoes manipulation and coercion, teasing and seduction, frustration and reward…Managing the pleasure of the a game’s players means translating the intricacies of the rules into an engaging experience of play” (Salen & Zimmerman, 2004). Jesse Schell is more direct: “Without the experience, the game is worthless,” (Schell, 2008).

To translate inert game mechanics into living experiences, I chose a phenomenological approach (Verbeek, 2005). When I want to discuss a game, I will play it. I will analyze my experience and report it. Then I will explore how that that experience fits with existing research.

Reading objects as text is frequently associated with material culture studies or anthropology. But it is used throughout the social sciences.

Historian Michael Mahoney argues that using a piece of technology, in his case the Ford Model T, is a powerful tool for research and communication. “The technical and cultural meaning of the Model T lie in the automobile as an artefact,” he writes, “To understand [Henry Ford’s] audience and the meaning they attached to the car, historians must see what they saw and feel what they felt, for their experience of the car was visual and tactile, not verbal or literary,” (Mahoney, 1985). Notice that he is not asking historians to understand what users saw or felt, he is encouraging them to *see and feel it for themselves*.

Within design research, Donald Norman uses his own experience to explore usability and the emotional value of design (Norman, 1988, 2007). To understand the experience of making tea, he makes tea. He looks at the teapots on his kitchen shelf. He reflects on why he owns each one, how they are used and how they were discovered. Then he comes to this conclusion: “Design is important to me, but which design I choose depends on the occasion, the context, and above all, my mood. These objects are more than utilitarian. As art, they lighten up my day. Perhaps more important, each conveys a personal meaning; each has its own story,” (Norman, 2007). His books, *The Design of Everyday Things* and *Emotional Design*, are filled with this form of object reading.

The foundations of design research are also built on personal accounts and object readings. James Gibson, for example, uses phenomenological tools to explore his “Theory of Affordances,” (Gibson, 2014). Not only does he refer to his own experience, he also includes the reader’s experiences, and the experiences of humanity at large:

> “Civilized people have altered the steep slopes of their habitat by building stairways so as to afford ascent and descent. What we call the steps afford stepping, up or down, relative to the size of the person’s legs. We are still capable of getting around in an arboreal layout of surfaces, tree branches, and we have ladders that afford this kind of locomotion, but most of us leave that to our children.” (Gibson, 2014)

Personal experience is a staple of games research too. Most chapters of James Gee’s *What Video Games Can Teach us About Learning and Literacy* are structured around his personal experience with a specific game. Here he is at the beginning of Chapter 3, describing how he will use an adventure-roleplaying game, called *Arcanum: Of Steamworks and Magick Obscura*, to explore learning and identity:

> “I first discuss this game and the sorts of identity work it recruits. Then I turn to learning in school, making comparisons and contrasts with learning in Arcanum and games like it. Finally, I continue the list of learning principles that are embedded in good video games, principles that are important for learning in any domain. Let us turn to Arcanum.” (Gee, 2007)

How does Gee learn about *Arcanum* and “the sort of identity work it recruits?” He plays it. He records what happens. He looks for learning principles within the game. He recalls his experience in similar games. Then he uses what he learns to frame his discussion.

Reading antique cars, teapots, stairs, video games and other objects is inherently subjective. But it is rigorously subjective. Mahoney, Norman, Gibson and Gee are not writing diary entries, they are documenting experiences and engaging with existing research.

When Donald Norman says that his choice of teapots depends on his mood, he isn't hiding a bias, or corrupting his data. He's acknowledging that his personal viewpoint affects his experience. His subjectivity doesn't negate the conclusion that each teapot conveys its own personal meaning. In fact, his biases—or his shifting moods—are a central part of the discussion.

This makes personal voice and attribution doubly important. When I'm recounting my experience in the player-versus-player arenas of *Star Wars: The Old Republic*, I want to be absolutely clear about whose story I'm telling. It will keep you—the reader—from being confused. It may also lead us to important insights.

A Few Useful Terms

This thesis is primarily about product design and learning. So I shall start by defining what I mean when I refer to products, product design, learning and learning design.

Most of the products in this thesis are physical artifacts. They are designed in studios, manufactured in factories and sold by the thousands in retail outlets. Occasionally I may refer to physical products, like pencils or musical instruments, or digital ones, like websites and apps, but my primary interest is hybrid products, like smartphones and digital cameras.

Product design is the practice through which those products are conceived. Designers plan out the functions, the features and the physical form. This is also where we build the user experience. What services will the product provide? How will it communicate with users? How will they communicate with it? How will it fit into their lives? Why will people want to use this product? Product design, or rather "user-centered product design," is where we answer those questions.

When designers talk about learning, we are usually referring to product literacy or the development of product literacy. We are not asking if users can read and write, but we are asking if they can understand and use our products. For the purpose of this thesis, I describe product literacy as comprised of two parts: understanding what a product is telling you, and telling a product what to do.

If we were discussing traditional letters-on-paper literacy, then "understanding what a product is telling you" would be the equivalent of reading the product. Every product conveys some amount of information. Even something as simple as a plastic fork says, "Hold this part. Poke your food with the pointy end." Literate users can recognize this information, process it and turn it into useful action. However, this starts to get difficult when the products in question are innovative and their operation and use different from what users are familiar with. This is also the case when products are complex, multifunctional, feature-laden and poorly designed. In such situations, product learning is not easy.

Basic literacy is a good start, but we often want our users to do more than just read and write. We want them to be poets. Many products, from musical instruments to smartphones, allow users to move beyond simple "this icon means x, this button does y" literacy. They reward creativity and exploration, and they offer a longer, more complex learning experiences.

In *What Video Games Have to Teach Us About Learning and Literacy,* James Gee calls this “The Insider Principle”. (Gee, 2007). “The learner is an ‘insider,’ ‘teacher,’ and ‘producer’ (not just a ‘consumer’) able to customize the learning experience and domain/game from the beginning and throughout the experience” (Gee, 2007).

Learning design is just what it sounds like: a deliberate path from ignorance to literacy. A learning experience can be designed just like a product, and I am arguing that a designed learning experience is preferable to an accidental one.

Gaming doesn’t have a monopoly on learning principles, like learning design and literacy. They actually come from learning theory and education, rather than gaming. But, as Gee demonstrates, they are right at home in gaming. And game design is a useful bridge between product design and learning theory.

Product Literacy and Consumer Research

Product literacy is not a common design term, but it does appear in consumer research and economics. Usually it refers to the ability to make good buying decisions. A consumer gathers information about a product, weighs the benefits and costs, then either makes a purchase or walks away. Literate consumers buy products that meet their goals, fit their budgets, and minimize harm to themselves (Kopp, 2012; Pappalardo, 2012).

If we focus only on the act of purchasing a product, then this fits well with my definition product literacy. Users read the signs, they process the information, and they take action with the product. In this case, the action is buying the product. But unlike Pappalardo and Kopp, I am more interested in what happens after the user acquires the product.

Gamification

One potentially useful term I will not use is "gamification."

If you have heard of gamification, you probably have your own idea of what the word means. This may include digital strategy services that use game mechanics to draw users to specific websites, or a free-to-play video game with an online store and a clever business model. You may have used a tablet game to teach arithmetic to your children, or played a movie-themed game that blurred the line between entertainment and advertising.

Gamification is a term that is still confusing to many people and therefore in need of clear definition. In 2015, Bohyun Kim collected and compared several definitions and examples of gamification from researchers, designers, educators and businesspeople (Kim, 2015). There is significant variation from one author to the next, but the comparison reveals two main points of agreement.

- Gamification uses elements of games...
- ...in non-gaming situations.

Everything else varies from one source to another. Which game elements? Depending on the writer, Kim reports that these elements can include game mechanics, game-thinking, user experience, or a host of other possibilities. Which non-gaming situations? Some writers limit gamification to specific disciplines, like education or business. Others apply it to broad, transdisciplinary activities like solving problems or helping users achieve their goals. Some of her sources assert that gamification is a purely digital tool, while others argue that it can be applied anywhere.

This study fits inside the broader definitions of gamification, like Zichermann and Cunningham's: using "game-thinking and game mechanics to engage users and solve problems" (Kim, 2015). The learning principles I explore are closer to "game-thinking" than game mechanics, so any definition that focuses on scoring points or following sets of rules, instead of the underlying experience, will not include my research.

Some authors argue that gamification requires specific technology or game mechanics. Kim herself asserts that gamification requires rules, competition and specific goals. By her definition, this thesis would fall under “playful design” instead of gamification. Other researchers, like Brian Burke or Adrian Dominguez, limit gamification to software applications. So my research would only qualify when it was applied to digital products. If I applied the same tools to a non-digital product the results would be something else.

This uncertainty makes the definition of gamification unclear and unhelpful, but that is not necessarily a bad thing. I see it as an opportunity—the first steps into an exciting and unmapped territory.

Mapping, describing and defining gamification is a task that falls outside the purview of this thesis. I can’t claim that my work is, or is not, gamification without choosing a definition and jumping into a contentious discussion. That conversation is worth having, but it doesn’t directly affect my specific partnership between games, learning and product design.

Who's Learning About Products?

Product learning starts with designers, during the fuzzy front-end of product design (Cagan & Vogel, 2002). At this early stage in the process, everything is unfocused while designers educate themselves about the user, the problem their product is meant to solve, and how it is intended to be sold. The intention is to follow the research without preconceptions or bias.

Sometimes, this is a quick process: a scan of the design brief and a brief conversation with coworkers and clients. At other times, it is a full-blown research project, involving research plans, user interviews, ethnographic studies and long nights in the library (Squires & Byrne, 2002). Either way, designers like to explore the project before starting the design process.

Design research has two goals. The first is understanding the product's domain. How will people use it? What do they need from it? What services should it provide? Then, once the designers have developed their own literacy, they plan how it will be passed on to the user. This is a little bit like being a remote-control teacher, something we will discuss in more detail when we get to games and learning design.

Users are the most obvious product learners. Every time they encounter a new product, a new feature or a new situation, they step into a new learning experience.

Imagine these three situations:

- You just replaced your home thermostat. The box says it does the same thing as your old thermostat, but the interface is different. The weather report says we are going to have record high temperatures today. How will you keep your house cool?
- You want to make your first call on a smartphone. You know it makes calls. They call it a smart*phone* for a reason. But all of the familiar features are hidden behind a new layer of technology. How do you turn it on? How do you activate the keypad? Where is your list of contacts?
- You are on vacation abroad and it is your first time behind the wheel of a rental car. You have never driven this model before. You are in an unfamiliar city with unfamiliar traffic laws. It is dark, it is raining and the windshield keeps fogging up. How do you reach your destination safely? Can you avoid getting a ticket? Where are the headlights, windshield wipers and defroster? For that matter, how do you turn the car on or put it in gear?

These are all learning experiences that are created by new (or just unfamiliar) products and situations. Some of them are more urgent than others. Some are more difficult. But all of them have a significant effect on the user experience.

Designers have control over how these learning opportunities unfold over time. They may not be able to make the learning easy, especially for complicated products like cars. But they can make the experience less risky and more rewarding by including good learning design.

Users and designers are not the only people who may need to learn a new product. The success of a design may also depend on how well other people learn it too.

Product development is rarely a one-person job, and it is important that all the collaborators understand the designs, even if they never actually use them. Engineers need to know what a product does, so they can make it work. Marketers need to communicate the user experience to customers. Intellectual property attorneys need to know what makes the product unique. And the design team works much better when everyone understands the product.

Well-educated business collaborators are critical to the process. In order to evaluate designs, employers and clients have to understand them. If retailers are to put our products into stores, designers have to show them why customers will want to make a purchase. If designers want a new round of investment for a start-up, they need to show investors why and how a product might be successful.

Designers may also have cooperative relationships with other designers. Imagine a situation in which a designer of smartphones needs to license another company to develop waterproof covers. In such a situation, they should know how the product works. Or software developers who want to build apps for the phone's operating system? Or medical device manufacturers who want to use the phone to control prosthetic limbs (Webster, 2013) or monitor blood sugar (Tran, Tran, & White, 2012)? The products and the partnerships will be much stronger when all the collaborators involved understand the user experience.

These learning experiences go beyond the product development process too. Regulators, journalists, reviewers, caregivers and other influencers will all be better equipped to support the designs if they can understand them well.

This thesis focuses primarily on how users and other non-designers learn about products. Since non-designers inhabit the space outside the design bubble, they often do not have the special inside knowledge that accompanies watching a product develop in the studio. Therefore, they have to learn by interacting with the products themselves.

Levels of Difficulty

How difficult is it to learn a product? That depends on the product. This can be understood by classifying products into two categories based on their complexity and how much learning they require: "everyday things" and "skill-based products".

This is a continuum, or a sliding scale. At one end, where everyday things reside, products are simple and it is easy to define successful learning. Most require very little learning. Sometimes, by carefully controlling what is possible and what is not, designers can eliminate learning altogether. At the other end of the continuum where skill-based products reside, things are a little more complex. Successful learning is subjective, and it may require years to master.

Some products can be located comfortably at one end or the other. Dining room chairs are simple. You bend your knees and place your backside on the seat. Success! In less than 3 seconds, you've mastered the product. On the other hand, trying to fly an F-22 fighter aircraft after only 3 seconds of learning, might lead to catastrophe.

But most products reside somewhere in the middle. Designers may be able to simplify some of the learning, but they cannot eliminate it altogether.

Everyday Things

As the name suggests, everyday things are items we use every day. Doorknobs, light switches, faucets, coffee-makers, desk chairs and telephones are examples of products that fall under this category. An estimated 20,000 and 30,000 different types of everyday things populate our lives (D. Norman, 1988). They perform simple jobs and they require very little learning.

For everyday things, successful use equals correct use. It is like solving a math problem. If you do all the right things, then you get the correct result every time. Push on a door handle, and the door opens. Move the tip of a pen across a piece of paper and a line appears. Flip a switch from "on" to "off" and the lights go out.

According to Norman, it takes three components to successfully use an everyday thing: "knowledge in the head", "knowledge in the world" and a series of "natural and cultural constraints".

Knowledge in the head is learned information. If you were calling a friend on your phone, this refers to the name and number of the person you are calling. Or if you are mixing up a batch of your favorite chocolate chip cookies (something you've done so often that you know the process by heart), this refers to the recipe.

Knowledge in the world is information that you do not have to learn. The things you use provide it for you. When you call a friend, you do not have to remember which button is “1” and which button is “5”. The numbers are displayed on the phone. When you put the cookie dough in the oven, you do not need to know how to keep it at the right temperature. You just set the thermostat, and the oven does the rest. If the recipe says you should bake them for 12 minutes, a timer can keep track of it for you. Well-designed everyday things require very little learning, because they already contain all the information we need to use them. That allows us to perform with great precision, without a great deal of learning or memorization.

Constraints are like knowledge in the world, but instead of communicating information they encourage specific behavior. They make useful behavior—the kind that will lead to a correct result easier, and render useless behavior more difficult.

Natural constraints are usually physical. They are built into the product and they limit how it interacts with users and other objects. A simple light switch, for example, has only two positions: "on" and "off". When it is in one position, the only thing it can do is move to the other one. This is a simple, highly-effective use of constraints that allows people to use light switches with a minimum of cognitive effort. Imagine if the switch could move in any direction like a joystick, but there were still only two outcomes. Users would have to search for the "on" and "off" positions. Turning off a light would go from a negligible task to one that took considerable learning and mental effort.

Psychologists and designers refer to these types of constraints as "affordances" and they can be powerful tools in the designer's kit.

Cultural constraints use general knowledge to guide behavior. When you place a call to a coworker, cultural constraints will probably cause them to say "Hello!" when they answer the phone, and those constraints encourage you to identify yourself and tell them the reason for your call. They are also likely to limit your conversation to specific work-related topics.

Want to make chocolate chip cookies? Cultural constraints tell you what chocolate chip cookies are (sweet, chocolaty desserts) and give you ideas about when to eat them (while they are still warm) and how to eat them (with glass of cold milk). They tell you where to make them (in the kitchen) and where to find the ingredients (in the pantry and the refrigerator). What if you want to add something special to this batch of cookies? When you open the pantry cultural constraints tell you to grab the chopped walnuts but leave the jar of green olives. Neither one is in the recipe, but you know that walnuts will probably taste good if you add them to the cookies and olives probably will not.

Cultural constraints have to be learned, but once they are learned they can be used in many different situations. Most business phone calls use the same set of constraints. And the constraints that apply to chocolate chip cookies would to any kind of cookie, and to brownies and cake as well.

Affordances

Designers frequently employ affordances to reduce the amount of learning it takes to use a product. But when learning is necessary, well-designed affordances can make it much easier. That makes them an interesting bridge between everyday things and skill-based products.

An affordance is the relationship between an organism and an environment (Gibson, 2014) and this is how it works. Imagine an ordinary, able-bodied person. That is the organism. Now put this person on a flat, smooth cement floor. That is the environment. Now, ask them to walk across the floor. They know how walk. The floor supports their weight and provides excellent traction. Therefore, they are able to walk across the floor. Or, in terms of affordances, the relationship between the floor and the person "affords walking". The floor, to the person, suggests walkability.

You will notice that affordances have their own vocabulary and grammar. When an affordance allows for a specific action, like walking comfortably, we usually say it "affords" that action (Greeno, 1994). For example, when I talk about the relationship between myself and the apple in my lunch box, I would say that "the apple affords eating." Alternately we can talk about an object's abilities. In this case, the apple in my lunchbox would be "eatable". I might also talk about the apple's "eatability."

Each affordance is unique to its organism and environment. Changes to either one will create a brand new affordance. Imagine the same smooth, cement floor mentioned above. To an able-bodied human adult, the surface affords walkability. But what if we replace that adult with an infant? The infant cannot walk, therefore the relationship no longer affords walkability. The same thing happens if we alter the environment. Replace the firm, smooth floor with a pool of water and no human, able-bodied or not, will be able to walk on it.

In order for a relationship to provide an affordance, all participants must be involved (Scarantino, 2003). A person standing on smooth, firm ground can wave their hands or speak. But these actions have nothing to do with the ground, and therefore the relationship is not providing an affordance.

A single relationship can provide multiple affordances. Although the pool of water does not afford walking, it does afford swimming, assuming, of course, that the person can swim. It also affords drinking, splashing and drowning.

Over time, the definition of affordances has expanded to include new relationships. In addition to organisms and environments, affordances can now also refer to the relationships between organisms and objects, organisms and other organisms, objects and other objects, and objects and environments. To a human, a rabbit might afford petting, playing or eating. To a volume of water, a bucket might afford holding or pouring.

Affordances may even arise from relationships between more than two participants. Give a person a hammer, a nail and a piece of wood, and we discover affordances for pounding. Toss that nail into a bucket of water, and the water might afford sinking or rusting. Not all of these relationships are of interest to psychologists, especially the relationships between non-living, non-thinking objects. But they are of great interest to designers and design researchers.

In addition to different relationships, affordances can involve different types of action or intention. Researchers distinguish between "goal affordances", which involve intention and "happening affordances" which do not (Scarantino, 2003). When a person picks up a hammer and pounds a nail into a piece of wood, they are using a goal affordance because they are acting intentionally. If that person accidentally steps on the nail and injures their foot, they are experiencing a happening affordance because there is no intention.

Why spend so much time on affordances? As I demonstrated in the last section, designers frequently use affordances as a replacement for learning. They prevent mistakes by making the actions that lead to mistakes impossible, or at least very difficult. And they steer people towards successful outcomes by making the actions that lead to successful outcomes as easy as possible. When the only way to use a product is the correct way, then it does not take much learning to use it.

Affordances are not merely alternatives to learning. They can also be powerful learning tools. They also form one of the strongest connections between game design and product design.

Designing with Affordances

So how do designers use affordances? As I mentioned above, they do it in two ways: by discouraging bad actions and encouraging good ones.

You can think of affordances like a garden fence. You do not want people to walk on your flowers, and therefore you install a fence around them. If someone really wants to walk on the flowerbed, they have to climb over the fence first. In the language of affordances, it decreases your garden's walkability. And that discourages people from walking on your flowers. If the fence is especially imposing, for instance if it is 10 feet high, electrified and topped with razor wire, it may prevent flower-stomping altogether.

When designers want to prevent a specific action, they do the same thing. They add locks, and guards and guides. They increase the cost of that action until it outweighs any benefit the user can get from it. Sometimes they even make the action impossible.

I have a food processor in my kitchen. When I turn it on, a pair of 3-inch blades spin, helicopter-style, at more than 25 rotations per second. They can turn almost anything—food, fingers, the eyeglasses that just fell off my forehead—into tiny chunks before I am able to reach the off switch.

Fortunately, the designers have used affordances to make it very difficult for me to put my fingers (or my glasses) in danger. The blades are enclosed in a thick plastic canister. The only opening is too small for my hand and more than 2 finger-lengths from the blades. The motor will not engage unless the lid is locked in place, and the lid cannot be unlocked while the blades are spinning. If you described the relationship between the blades and my fingers, you might say that the blades were unreachable or my fingers were unchoppable.

There are times when we want to encourage a specific action. What if you are really proud of your garden? You want people to see it, but you still do not want them to step on the flowers. So you add a path. It is smooth. It is even. It gives you the best possible view of a beautiful garden. Walking on the path is easy and enjoyable. Walking on the flowers is not. The affordances—walkability and enjoyability—encourage people to stay on the path and off of the flowers.

The food processor works best when the food is already cut into 2-inch chunks. Larger pieces can get wedged above the blades, where they will never be chopped. In case that happens, I have to turn off the processor, wait for the blades to stop spinning, unlock the lid, unwedge the food, and put everything back together. The designers knew this, and therefore they built in a special affordance that encourages me to pre-chop my ingredients: a narrow opening that only accepts 2-inch (or smaller) ingredients. Small pieces are insertable. Large pieces are not.

The Limits of Affordances

Affordances are useful tools, but they have limitations. The more we guide users' behavior, building barriers to prevent undesirable actions and smoothing the path towards desirable ones, the more we limit users' creativity and freedom. Our product may encourage perfect behavior, but they leave little room for innovation or fun.

And what happens when affordances are not enough? Perfectly designed affordances can force a user to perform the correct series of actions, but it can be an awkward process. Imagine a swimming instructor holding the hands of a student and manually guiding them through the motions required for backstroke. Compare that to an Olympic swimmer winning the 200 meter backstroke. In a loose sense, both swimmers are performing the same activity. But one scenario is the awkward result of a novice being pushed and pulled through the motions. The other is the result of thousands of hours or learning and practice. The highest levels of success come from real learning on the part of the user. They cannot be forced on the user with well-designed affordances.

Of course, there are products where Olympic-level expertise is not particularly valuable or necessary. How many people want to be masters of their bathroom sink or their lunch box? For these simple, everyday objects, affordances are probably sufficient. As long as their water is the right temperature and their lunches arrive safely at work, there is very little to distinguish an expert user from a novice.

But many products have room for learning and expertise. This is especially true for digitally enabled products like smart phones, DVRs, and cloud-computing services. With these designs, our goal should be genuine expertise. That requires effortful practice and opens the door to failure and frustration.

Effort, failure and frustration can be scary user outcomes for designers, and they work very hard to eliminate them. But, since failure and frustration are necessary for developing expertise, how can we embrace them? How can we make them positive parts of the user experience?

Fortunately, pleasant frustration and effortful practice are key components of a well-designed game (Gee, 2007). This is an area where game design can be very useful for designers.

Skill-based Products

As their name suggests, skill-based products are often associated with a specific set of skills. Musical instruments are associated with musical skills, like the ability to read notes, make a pleasing sound and carry a tune. Sporting equipment is associated with sporting skills, art supplies with artistic skills, game consoles with gaming skills, and so on.

Skill-based products may be used every day, but unlike everyday things, they are not simple. Success is subjective. Perfect action may be possible for an expert, but a successful use will vary from one user to another. It may even change as a user's skill-level develops. A novice guitar player may be happy to play a few notes without thunking or buzzing. An intermediate-level musician may want to play entire songs, exactly as written or exactly like they sound on the radio. An expert may prefer to write their own music or improvise on the work of others.

Most skill-based products also require a great deal of learning. Depending on the user's goals, they may even require a lifetime of experimentation, discovery and practice. To an observer, these experiments and practice sessions may look like failures. Melodies may be awkward and filled with sour notes. Shots may miss the basket over and over. But the user keeps practicing anyway.

Why do we keep using these difficult products? Why do we inflict all of these failures upon ourselves? Mihaly Csikszentmihalyi, a psychologist who studies creativity, play and happiness, asserts that these activities have their own special rewards that may not be obvious to an observer (Csikszentmihalyi, 1975). Users are motivated by the activities themselves. Even when they appear to fail, they are still building their "self-confidence, contentment, and feeling of solidarity with others." Jane McGonigal argues that they are looking for their next "epic win," and they are confident that it is just around the corner (McGonigal, 2011).

This may explain why people pursue difficult-but-fun activities like music, sports, art and gaming. But what about skill-based products that are not built for entertainment? What about cars? Predictive analytics software? Surgical tools? Mastering these products requires a lifetime of practice, learning and failure. How are the learning experiences for these products?

Smartphones and Skill-based Everyday Things

I will to refer to smartphones frequently in this thesis. That is partly for convenience. Smartphones are nearly perfect examples of the concepts I intend to discuss. They are flexible and highly customizable. They change functions and features frequently. They have a quick obsolescence cycle. They are platforms for other products and components of larger systems. And they straddle the line between "everyday things" and "skill-based products".

Smartphones are also important to users, designers and manufacturers. In the US, more than 60% adults currently own a smartphone (Pew Research Center, 2015). Worldwide, we purchased more than one billion of them in 2014 (Gartner, 2015). We use them for an increasingly wide range of daily activities, from making calls, to accessing the internet, to playing games, to listening to music (Duggan, 2013) (ESA, 2015). And they are key components in many in many of our most innovative companies and industries, either as products, like Apple's iPhone (Wakabayashi, 2015) or as parts of larger systems, like Uber's ride-finding app (Ritholtz, 2015). Few consumer products have the same reach, or the economic value. And, as we develop new ways to use mobile technology, few products have so much potential for new design.

The ubiquity of smartphones also makes them great points of reference. If you are reading this in the US, then you probably have at least one. Even if you do not own a one yourself, you have probably used one, or at least seen one in action. So when I refer to "apps" or "text messaging", or other common smartphone features and functions, we all know what I am referring to. Even though smartphones are a young technology, there is a wealth of information available on the phones themselves, their users, their manufacturers, their applications and their challenges.

Although I think smartphones are appropriate examples, many of these concepts can apply to other products as well. The most obvious are the smartphone's "pervasive computing" cousins, like tablets, smartwatches and Google’s smart eyeglasses called Glass (Hunter, 2008). Like the smartphone, they bring computers out of the office and into the world, and they embody future flexibility. But they are still maturing. In 5-10 years, there may be even better examples than smartphones.

Other products, like cars, digital cameras, personal computers, and many kinds of professional equipment are good fits too. They may not embody all of the concepts here, but they do fit most of them very well.

The Case for Learning Design

Whether we plan for it or not, learning is a big part of the user experience. In the next few pages, we will explore four occasions where learning design and product design overlap. In some of them, learning is already thoroughly entangled with product design. In others, learning design is just starting to creep in.

First, we will examine how design creates new learning experiences. Every new product is a new opportunity for learning and creates new learning opportunities throughout its lifetime.

Then we will explore the links between learning and usability. In the past, users were satisfied with functional yet difficult products, like VCRs that played movies on demand, but rarely displayed the correct time (Mack & Sharples, 2009). Now, they expect usability and a satisfying learning experience.

After that, we will examine the rise of skill-based everyday things. These new products have the ubiquity of everyday things, but the complexity of skill-based products. They enable us to do interesting new things, but they also force us to do a lot of learning.

Products are not the only things that are changing. Users are changing too. So finally we will discuss how cultural changes interact with product design, and how those interactions create new learning.

More Design = More Learning

Design changes things. When we create new products, we alter something in the world. We create new ways to perform old tasks. We provide new information. We make new connections and interactions. These changes ask people to unlearn something and replace it with something new.

Depending on the depth of change, we may be asking for a lot of learning. The automobile, for example, asked people to forget what they knew about getting from one place to another. If they wanted to take advantage of this new form of transportation, they had to learn an entirely different set of skills.

Every person who encounters a new product, as a user or a bystander, may need to learn something new. By 1927, Ford had produced more than 15 million Model T cars (Tweeten & Ford, 2008). Each new driver learned how to operate their car. At the very least, their neighbors learned how to avoid being run over in the street. Entrepreneurs learned how to repair automobiles and provide them with fuel. And, as more people in each community purchased Model Ts, everyone learned how to navigate and manage traffic.

In the following sections, I will examine some of the ways in which design is creating new learning situations. How are we creating them? What are we asking users, and bystanders, to learn? How are they reacting to these new learning situations?

Changing Activities

When a design is brand new, it is easy to spot the learning opportunities. Before the design, a task was done one way. After the design, it is done another way. The design changed the way that people did something, and that new way requires new learning.

Before the telephone, long-distance communication was challenging. If you wanted to communicate with someone in another city without leaving home, you had to send a message. The message, whether it was a letter, a telegram, or something you told your friend before they got on a train, had to travel from your house to their house. They had to read it (or listen to it), compose a reply and send it back to you. Immediate, person-to-person conversation was nearly impossible.

After the telephone, you could pick up a handset and talk with them directly. Person-to-person communication changed, but we had to learn a new set of skills to use it effectively. We learned how to operate the phone. We learned the contact information for our family members, friends and business associates.

We also learned a new form of etiquette and a new set of social norms. What should I say when I answer the phone? How loud should I talk? Is 9pm too late to call? Is 5am too early? I just got a new job. Should I call my parents or send them a letter? What about all my clients?

Today, ubiquitous computing technology, like the Glass from Google, is creating similar learning challenges for users and for bystanders (Ladhani, 2014). These wearable computers look a lot like eyeglasses and use a gestural and verbal interface to take photos, record audio and access information. Users are learning how to operate the interface and exploring the devices' capabilities, but they are also discovering that Glass changes their social interactions. Sometimes it even creates conflicts.

The device's camera has been a major point of contention. Glass makes it very easy to make surreptitious video recordings. Instead of holding up a camera or a cell phone, users can simply face their subject and activate the recorder. Without the familiar visual cues, no one knows that the camera is rolling. This worries a lot of people, including privacy advocates, businesses that don't allow photography, and anyone who does not want to be recorded without their knowledge or permission.

Omer Shapira is a network TV producer and a graduate student at New York University's Interactive Telecommunications Program (ITP). Last year, Shapira wrote a description of an ITP show where he encountered several "overzealous trendhunters" wearing Google Glass (Shapira, 2014). Concerned that his work, and the work of other presenters, was being recorded and potentially stolen, he offered this suggestion:

> ...if you're recording the conversation without asking for permission -- you're just an asshole. That shouldn't surprise you if you've had Google Glass on your head in any other social situation, but now you're literally suspect of trying to steal an idea. Kindly and promptly remove yourself. (Shapira, 2014)

He finished the article by saying, "For fuck's sake, remove your Google Glass when talking to presenters. Not all sufficiently advanced technology is socially acceptable."

Shapira's reaction may be colorful, but it is not unique. Glass users frequently encounter hostility. Newspaper articles refer to them as "Glassholes" (Ladhani, 2014). Restaurants forbid wearing the product, and parents treat them with suspicion when brought to kids' events (Schuster, 2014). Glass users have been physically attacked by people who did not wish to be recorded (Alexander, 2014) and their equipment has been stolen or destroyed (Gross, 2014).

Designers have even started making anti-Glass products. Cyborg Unplug, an anti-surveillance company, claims that their product can alert users when surveillance devices, like Glass, Dropcams, wireless microphones and drones, are nearby and disrupt their wireless connections (Greenberg, 2014).

There is a lot to learn on both sides. For Glass users, the tasks of taking pictures and recording video have changed. So they need to learn new ways of taking pictures and recording video. That is relatively easy. But Glass has also changed how they relate to people. Now they must learn how to interact with a curious and occasionally angry world.

For bystanders, Glass has changed what it means to be in public. When Glass users look at my children, are they just looking, or are they taking pictures? When I talk to Glass users, are they recording what I say? Will that embarrassing moment be forgotten? Or will it be recorded and posted on YouTube? How do I know when I am being filmed? How can I keep it from happening?

We can hope that these tensions will resolve themselves as everyone involved learns more about Glass. The two sides may never be completely comfortable with each other, but learning may make them less openly hostile. In the meantime, Glass is a useful reminder of how much learning, and how much misunderstanding can arise from a new product.

Accidental Changes

When a design changes an activity, that change is often deliberate. Designers see how something worked. They imagine a way to make it better. They introduce a product, and now that something works differently. People are learning something new, but the designer was prepared for it. Hopefully they designed a good learning experience.

It does not always happen that way. Sometimes change happens whether we planned for it or not. If our product is part of an activity and that activity changes, then how people use our product changes too. They are relearning our product even if we did not plan for it. To us, that is an accidental learning situation.

Latent functions are a great source of surprises. Regardless of how careful designers are during the design process, it is not possible to see all the ways in which products can and might be used. We are no match for the ingenuity of hundreds of thousands of users. They use products in unexpected ways. They force the products to fit into their lives, instead of the user-experience scenarios we created in the studio. They transform how are products are used, and they learn things about products that designers never expected.

Have you ever been startled by the sound of a vibrating cell phone on a wooden table? That is a latent function. Or, if it disturbs you as much as it does me, a latent <u>dys</u>function. My phone's operating system refers to "vibration only" mode as "silent mode" or "manners mode", and we expect it to be silent, or at least politely quiet. When my phone is in my pocket, this works beautifully. But set the phone on a hard surface and a polite vibration can be just as disruptive a full-volume ringtone. After a few embarrassing moments, I have learned to expect this. If I do not need my phone during a meeting or a presentation, I turn it off. If I do need it, I make sure to set it on something soft, like the pages of my sketchbook, to dampen the sound.

The phone's designers did not plan for this to happen. In fact, they are trying to fix the problem (Whitney, 2012). Until they do, users will face an unexpected learning situation.

Sometimes, an unexpected learning situation is not an accident. Users may modify their products, or other designers may disrupt how our products are used. An entire community of "IKEA Hackers" has developed around the Swedish company's inexpensive modular furniture (Wilson, 2014). Their work is brilliant and creative, transforming bookcases into hamster cages, shopping bags into raincoats and end-tables into electric guitars (Kushins, 2014).

These modifications, and the modding community that engages in this activity, were not part of IKEA's plans. In fact, IKEA started trademark violation proceedings against IKEAHackers.com, one of the community's most popular sites, in 2014. They forced the site to close down for a few months, before reconsidering and withdrawing their complaint. IKEAHackers.com is running again, and it is an amazing showcase for user-built modifications.

We will take a closer look at user modifications later. For now I want to point out that modifications like this require a special kind of learning. Depending on the extent of the modifications, modders may not need to know how a product was supposed to work. The user who turned a butcher-block end-table into an electric guitar was not interested in decorating their living room. He was interested in tone, grain patterns and tuning stability (Z. Anderson, 2007). Instead of learning the original designers' vision, modders need to how a product was put together, how they can take it apart and how they can make it fit into their own designs.

Other designers can also change how people use products. When smartphones first added web browsers, web page designers did not intend for their products to be viewed on small screens. So users had to learn a new way to look at the web, one that used a smaller device and relied on a touchscreen instead of a mouse. When would they need to zoom in? Where could they put their fingers so they could drag a website across the screen without accidentally bumping a link? How could they select the right link when several of them were packed close together? How would interactive features, like menus that appeared when you hovered over them with the mouse pointer, work when you had no mouse and no pointer?

Since then, web designers have developed new approaches, like "responsive web design", which reconfigures pages based on the size of a device's screen (Frain, 2012). They have reduced the amount of learning it takes to use the most up-to-date pages, but there are still many old-style static websites on the Internet, and lots of surprise opportunities for learning.

When culture shifts around a product, it can force us to relearn how we use it. Things that used to be acceptable, like talking on a cell phone while driving, may become unacceptable. In some places they have even become illegal. Sometimes this encourages us to learn a new skill. If operating our cell phone without taking our hands off the steering wheel will keep us from getting a traffic ticket, we may learn how to use voice commands and the speakerphone. It may also require some social learning, as we discover which of our friends and family feel strongly about using the phone while we drive, or what the laws regarding cellphones are in our community.

If our products last long enough, they may even require new learning through obsolescence. Look at the rotary telephone. At one point in history, we made nearly all of our calls on rotary phones. Now that we have moved on to touch-screens and push-buttons, our rotary-dialing skills are no longer necessary. Many young people may never have learned how to use that type of phone at all. Through nostalgia, stubbornness or neglect, some rotary phones are still in service. When we stumble upon them, we either have to relearn how to use them or, if we never used one before, learn them for the first time. They are so old that they have become "new" to an entire generation of users.

Changing Products

We like to think of consumer products as unchangeable, interchangeable things. Many of them are mass-produced, in the same facilities, using the same carefully engineered parts. They use durable materials. They are carefully tested for reliability and safety. Predictable products are the promise of mass production.

I am an illustrator, and I buy a lot of pencils. My favorite is the Prismacolor Premiere Black. They are available in bulk from most art stores, and I usually have at least 50 in my desk drawer. When I pick up one of these pencils, I have very specific expectations. I know how long it takes to sharpen it to a fine point, and how long I can work before I need to sharpen it again. I know how lightly I need to press to get soft gray shading, or a thin black line. And I know how hard I can push before the lead breaks.

In theory, all of the pencils in my drawer should behave exactly the same way. And each pencil should be consistent, from the first time I sharpen it, until it is a 2-inch nub. But it does not always work that way.

Maybe I dropped the pencil on a cement floor or let it rattle around in my backpack for several weeks. Now the lead is cracked and I have to handle it very gently to keep it from breaking altogether. Maybe I grabbed the wrong color in the store and I have figure out how to make my new sketches match the old ones. Maybe the store wrapped one end in a thick adhesive price tag, and it will not fit in my pencil sharpener. Now I have to relearn how to get a reliable point. Maybe the company switched manufacturers recently and the new pencils are thinner than the old ones. Now they are too thin to fit in an extender, and I have to find a new way to hold a pencil stub.

Every product has permutations like this. They may look alike, and they may function alike when they leave the factory. But entropy does not let them stay that way, and each product creates its own unique learning situations.

Many products need to be broken in. It is a familiar part of the new product experience, from new shoes to new cars. This may be a strict regimen, like a series of oil changes and service calls for a new car (Allen, 2010). Or it may be an intuitive process, like wearing a pair of athletic shoes around the house until you are confident they will not give you blisters.

The other end of a product's life cycle has its own set of changes. As they age, the running shoes that fit perfectly when they were new may lose their cushioning. They may not feel so good any more. They may even contribute to injuries (Chambon et al., 2014). The car that was carefully broken in and diligently maintained, will need repairing. Over time, its owner may need to learn special skills, like coaxing an aging engine to life on a cold day, opening the door when the lock is stuck, or replacing a dead battery in the parking lot of a Wal-Mart.

Quirks in the manufacturing process may keep products from being completely interchangeable too. Even if a design stays the same, manufacturers may change materials from one product run to another. They may have to adjust the process to fix a problem. Or they may need to recall and alter faulty products.

For the next few pages, we will look at some of the ways that products change once they leave the design studio. And we will ask what kind of learning experiences these products create.

Updatable Products

A designer's job is usually done once their product lands in the hands of a consumer. But sometimes we keep making changes through updates, upgrades, repairs and recalls.

Updates are a common thing for digital products. Websites may change their concept several times a day, and may update their user flows and layouts every few months. Computer operating systems update several times a year. Microsoft, for example, has been sending out Windows updates on the second Tuesday of nearly every month since 2003 (Keizer, 2015). These updates do not always change how people use their computers, but they frequently include interface updates and performance adjustments. Each one is another opportunity for learning.

Upgrades are a lot like updates, only larger. Patch Tuesday may put a new button on my computer's home screen, or change the way that the audio player keeps track of my music. But upgrading from Windows 8 to Windows 10 may change the whole experience. It may take several weeks to understand all of the changes.

Although we do not download the changes, physical products can be updated in similar ways. This may come from routine repairs. You could not start your 10 year-old car without pumping the accelerator, so you took it to the shop. Now it starts right up, and pumping the accelerator just scares the neighbors. The task of starting your car has changed, and you had to learn, or relearn, how to start it.

The changes may also be part of a company's efforts to fix a design flaw. Apple's iPhone 4, for example, had antenna problems (Helft, 2010). When users touched a certain part of the phone's case while making a call, they lost their connection. The danger zone was located at the bottom left corner of the housing, a spot that users frequently touched when they held a phone to their ears. To keep from dropping their calls, users had to learn a new way to hold the iPhone 4. Apple addressed the problem by offering users a "bumper": a plastic case that covered up the sensitive part of the phone, and kept users from touching it accidentally. With the problem fixed, users were able to relearn how to hold their phones.

Metaproducts

Metaproducts, designs that are made of many smaller products, are especially changeable. Changing one component can affect the entire system.

These integrated products feel like a modern invention. Inexpensive computer processors, wireless connectivity and the Internet have given us fitness monitoring systems with wearable sensors and smartphone apps to monitor your vitals and activity levels, desktop tracking software to manage the data, and online communities to share your results. Smart homes combine light fixtures, thermostats, cameras, sensors, and apps to allow users to control their homes and monitor their condition remotely. And the "internet of things" promises to link just about any of our electronic devices.

But composite products have been manufactured for decades. My mandolin, which was made in the 1940s, includes components from at least seven manufacturers. Strad-o-lin supplied the body. D'alessio made the strings. Grover made the tuners. And so on. Each component has its own unique characteristics, and each one changes how the instrument sounds and performs. The tuners, for example are a modern upgrade. When I purchased the mandolin, the original tuners were corroded and heavily worn. I could still use them to adjust the strings, but they were very stiff, difficult to fine-tune, and they fell out of tune quickly.

Although it sounded beautiful and "old timey", I had to treat the mandolin very carefully. I could not tune it in advance, it took a long time to tune, and it could only be played for about 30 minutes before it went out of tune again. If I played it outside, where changing temperatures can cause strings to expand and contract, it wouldn't last more than 15 minutes. Just stepping from the shade into the sun was enough to make it sound like a jangly saloon piano. So I replaced the tuners. The new set had a friendlier gear ratio (to make them easier to turn), less play (to make them more precise), and more stability (so they stayed in tune longer). They solved my tuning problems, and they allowed me to do new things with my mandolin, like play all day at the local renaissance faire.

Other complex products, from sports equipment to automobiles, may work the same way. The specific combination of components gives the product a specific set of capabilities and limitations. Change one component, like a set of tuners, and you change what the product can do. That creates new learning opportunities.

Platform Products

Platform products, like smartphones, are especially changeable. Depending on their software, accessories and configurations, their functions can change completely. They may even appear to be completely different products.

A platform product is more like a toolkit than a stand-alone design. Users, and other designers, are encouraged to add to it and transform it into something new. Once it is loaded with software, a smartphone could be a camera, a handheld gaming device, a music player, a web browser, or a nearly infinite number of other things. It can even function as several different devices at once.

In many cases, the device's physical form does not change along with its function. No matter what app you run on your phone, it still has a touch screen, a microphone, some speakers, one or two camera lenses, an LED flash, an accelerometer and a handful of physical buttons. You just use them differently to achieve different results.

My phone has two volume buttons. Most of the time, these buttons do exactly what you would expect them to do. One button makes sounds louder. The other makes them quieter. Sometimes it can be a little tricky though. The actual phone app has two different volumes, one for the ringer and one for the voice at the other end of the line. So I need to know when the volume buttons will affect one function or the other. Occasionally, the volume buttons do not control volume at all. When I am using the phone as a camera, the volume buttons control the zoom function. But that is just one camera app. When I use a different app, they operate as shutter buttons instead.

Every time a user reconfigures a platform product, they turn it into something new. That can lead to new learning experiences throughout the life of the product.

Usability and Learning

Usability is vital to a product's success (Billeter, Kalra, & Loewenstein, 2011). This is intuitive, almost painfully so, but sometimes we need to write it out so we remember it clearly: if people cannot use a product, then the product will not be used (Debora Viana Thompson, Hamilton, & Rust, 2005). The usual paths to adoption will be blocked. Frustrated new users will set the product aside or trade it in for something they can use. Potential users will not see it in action and they will not hear about it from their friends, family or social networks. Good marketing may get it into the hands of a few users, but it will not travel much farther.

The perception of usability is also important. When potential users evaluate a product, they do not just look at the price, the features and the aesthetics. They also estimate how much mental effort it will take to use the product. If it looks like the product will be difficult to learn, they may reject it and look elsewhere (Murray & Häubl, 2007). This can lead to "cognitive lock-in", where people prefer products they have used before to unfamiliar products. Cognitively, it costs less to stick with an old friend than it does to try something new.

When there are no familiar products to choose from, for example, when users are looking at a brand new design, they still try to find a good fit for their skill level (Burson, 2007). Marketing researchers call this "skill matching". Users imagine what it is like to use a product. They evaluate their own level of expertise. Then they try match things up. When they are confident in their ability to use a product, they are willing to take a bigger risk.

Finding a product that truly matches your abilities is not easy. Unlike aesthetics and build quality, usability is not obvious when you look at a product (Mack & Sharples, 2009) (D. Norman, 1988). Until you actually try it, you do not know if it is a good match. The best you can do is guess. A short trial period may not be enough. A good first experience may make the user unnaturally confident, while a bad one may convince them that the product is less usable than it really is. These brief experiences are not good indications of future success, but they can have powerful impacts on the perception of usability.

Burson illustrates this by describing an experiment (Burson, 2007). A group of graduate students from the University of Michigan went to a putting green. They were randomly put into two groups. One group attempted ten putts from the distance of 3 feet. The other group attempted ten putts from the distance of 10 feet. Afterward, they were presented with several 12-packs of golf balls, ranging from $9.95 "1st timer" balls, to $39.95 "professional" balls, and asked which one they would purchase for their own use. Then they were asked to rate their golfing ability. Not surprisingly, the students who putted from 3 feet made more putts. They were also more confident in their abilities. While the 10-foot group estimated that they were in the 15th percentile, the 3-foot group believed that they were in the 35th percentile. When asked about which balls they would purchase for themselves, the 3-foot group was willing to spend significantly more.

Compared to the lifetime of a ball, especially one that is only used on the putting green, ten putts is not enough to accurately predict anything. But ten putts, taken from a randomly selected distance, was enough to have a significant impact on the students' self-confidence and their purchasing decisions. That brief experience miscalibrated their knowledge (Alba & Hutchinson, 2000).

This brings us to a second problem: users are not good at self-evaluation. Most of us, regardless of our actual level skill, tend to over-estimate our abilities (Burson, 2007). A bit of user overconfidence is actually good for designers, because people are more likely to buy products they think they can use. But that confidence is fragile. A single bad experience can turn a confident user into a pessimistic one, and pessimistic users are less likely to buy a challenging product, or stick with it when they run into problems (Billeter et al., 2011).

The path from novice to expert can involve a lot of false starts, mistakes and failures. Each one can damage users' confidence, and make them less likely to persevere. How do we prevent that? How do we build their confidence, and encourage them to throughout the learning process?

It starts with a good first impression. We demonstrate that the product is usable, right now, even if the user is a complete novice. New users may be clumsy. Their first experience may not make full use of a product, but it should be a success. It should also help users see a clear path from where they are to where they want to be.

That first impression gets us out of the store and into the user's hands. Now we have to build on it. This is where a well-designed learning experience becomes really important. It does not need to be easy, but it does need to be satisfying. And it needs to encourage users to keep walking up the path, even when they stumble.

Smartphones and Skill-based Everyday Things

Smartphones should not exist. On paper, they are usability nightmares: a nearly infinite number of options, endlessly shifting interfaces, rapid upgrade cycles, and minimal standardization. But in the real world, they are wildly successful. In the US, more than half of us have a smartphone (Pew Research Center, 2015) and they are integral to some of our largest industries and most popular activities.

How does a theoretically unusable product reach so many people? And what does it say about learning and product design?

Smartphones, and their cousins, like smart watches and tablet computers, break many of the rules of usability. Nearly every step of the user experience has extra layers of complexity. In addition to having multiple manufacturers, they also have multiple service providers and several different operating systems. Each one has its own quirks.

Two identical phones, purchased from two different carriers may have two different networks. Stand in a tricky spot, and one may be able to make calls, while the other cannot. Stand somewhere else and it is reversed. The same two phones may have different payment plans. One carrier asks you to pay $20 every month, while the other gives the phone to you free, as long as you sign a two-year agreement. When the phone breaks, one carrier may give you a new one, the other may ask you to wait for repairs. These are not things you have to worry about with most products.

This differences become starker once users add apps to their phones. Each app comes with its own interface and its own functionality. Even apps that claim to do the same thing, like taking pictures or playing music, may do so very differently. The wide range of available apps means that each phone can be come functionally unique as users add exactly the apps that they want. The process may continue for as long as the users owns the phone.

When designers keep adding feature after feature to a product, we call it "feature creep" and we usually think of it as a bad thing (Debora V Thompson & Norton, 2011). More functions lead to more complexity. More complexity makes products more difficult. Toss enough functions onto the pile and the product becomes unusable.

Donald Norman may be the patron saint of usability. His book, *The Design of Everyday Things* is a standard textbook for design students and has been cited by researchers more than 13,000 times (Google Scholar, 2015). The book is filled with examples of poor design: doors that cannot be opened, watches that cannot be set, phones that cannot be answered, and car radios that cannot be tuned. Each case is analyzed and described in friendly, conversational language; the kind a professional designer might use when describing usability to a client.

But when Norman discusses "creeping featurism" he sounds more like a fire and brimstone preacher (D. Norman, 1988). It is "a disease, fatal if not treated promptly," he writes, and warns designers against "the worshipping of false images" like unnecessary complexity and the "appearance of technical sophistication." He concludes by encouraging designers to consider the victims of feature creep.

> You might argue that this is a victimless sin, hurting only those who practice it, but this is not true. Manufacturers and designers produce products for what they perceive as their market demands; therefore, if enough people sin this way -- and the evidence is that they do -- then all the rest of us must pay for the pleasures of the few. We pay in fancy, colorful-looking equipment that is nearly impossible to use. (D. Norman, 1988)

By this measure, smartphones are cardinal sinners. They start with an unusually complex product, then they allow users to pile on an endless variety additional features. The result is fancy and colorful. But is it impossible to use? The ubiquity of smart phones says "no". Smartphones are everywhere. They are the foundation for other industries, and change the way we do everyday tasks, like buy groceries, find transportation, or communicate with our friends. They are transforming how we consume media and browse the Internet. And they are spawning spin-off technologies, like tablet computers, smart watches, and wearable technologies.

Smartphones change the way that people interact with everyday things. People still use them every day, but they do not expect them to be easy to learn. Instead they treat them like skill-based products. They form life-long relationships with the product that involve exploration, creativity and learning (Mack & Sharples, 2009). They might not practice as diligently as a musician, but they treat their phones more like a favorite instrument than a simple tool.

This is where learning design becomes important. Smartphone designers are not building a simple everyday thing that can be mastered in a few minutes. They are building something that may provide new challenges throughout its lifetime. But they might be selling it to users who expect a simple, everyday thing experience.

These shifting expectations are not affecting too many products right now. Even if a person had a smartphone, a smart watch, a tablet computer, a gaming console and every type of wearable technology on the market today, the dumb products would still outnumber the smart ones by more than 1,000 to 1 (D. Norman, 1988). But smart products are hugely influential. We can expect to see wider changes as technology and user expectations evolve.

Users Are Changing

Products and activities are not the only things that are changing; users are evolving too. This is partly our fault. Designers, and our partners in business and engineering, have created new roles for users. They are not just customers any more, they are also builders, installers, repair-persons, and design partners.

Remember the last time you bought a desk, a bookshelf or a kitchen table? Did it come fully assembled? Did the retailer deliver it to your home? Or did you move and assemble it yourself?

Flat-pack furniture is not a new thing. From Michael Thonet's bent-wood chairs to Erie J. Saunder's knock-down tables, manufacturers have been shipping unassembled products since the industrial revolution. Originally they relied on their business partners, like retailers or installers, to assemble the furniture when it arrived.

In the 1950s, ready-to-assemble furniture emerged, and the responsibility for assembly shifted from retailers and installers to the users themselves. Today, consumers can buy ready-to-assemble furniture kits in most department and hardware stores, and the largest furniture retailer in the world, IKEA, relies on customers to assemble most of its products.

Building, installing and maintaining furniture require a new set of skills for consumers. They need to use tools, figure out special fasteners, move around heavy objects (without damaging the furniture, the building or themselves), and position them safely so they do not collapse. Designers try to make this as painless as they can. IKEA, for example, makes a step-by-step, language-free instruction pamphlet for every one of their products (IKEA, 2015) and they post assembly videos online (IKEA USA, 2013).

It can be a challenging, high-stakes learning situation. There is no opportunity for practice, and a wrong turn can damage your new purchase or injure your body. It may even endanger your marriage (Potkewitz, 2015). But IKEA's efforts demonstrate how important it is that consumers learn how to build their furniture.

When things go wrong, we also ask users to serve as troubleshooters and repair technicians. We give them written documents, on-line forums, automated systems, chat assistance and call-in help centers, but they are asked to solve many problems on their own. Like assembling a product, this can be a difficult, emotionally-loaded learning experience. Something has already gone wrong, and now users are forced to use their products in unexpected ways.

Designers are also inviting users into the design studio. The design research relationship has evolved. Design research techniques have become more sophisticated, especially online. We can track user behavior and turn metadata into actionable insights. For better or worse, it lets us reach very deeply into many users' lives.

For their part, users have become more aware of when they are being monitored and what businesses are doing with that information. Everyone is sorting out what is polite, what is ethical and what is profitable in this new environment. Users are also finding new ways to communicate with us and with each other. Online communities, review sites, and a wealth of personal communication tools allow them to identify problems, figure out ways to solve them and broadcast their experiences very publicly. A bad product experience, like Apple's "Antennagate" fiasco can appear online, earn its own nickname and be broadcast around the world before a company can even evaluate the problem (Helft, 2010). Or it can turn an unknown product into a world-wide phenomenon.

Many users are not waiting for an invitation. They are redesigning products for themselves. Some products, like cars and trucks, have a long history of user modifications. We have been altering them ourselves, or paying skilled craftspeople to alter them for us, for their entire history.

Modding used to be the domain of the expert and the adventurer. You needed special skills and tools, especially if you wanted a high-quality result. A dash of recklessness helped too. If you worried about ruining the thing you were working on, you might never get started. But easy access to information and professional manufacturing tools, like laser cutters, CNC mills, and 3D printers, make modding easier and more reliable than ever (C. Anderson, 2012).

It is up to us to decide how much we want to embrace this. We can glue our products shut and use proprietary tools to make them as tamper-proof as possible. We can build entire businesses around user modifications. No matter what we decide, users are probably going to tinker with our products. That requires a lot of learning.

Conclusion

We have looked at several different ways that product design creates opportunities for learning. New designs require new learning. So do new or changing activities. Even without a new design, existing products can create learning situations as they age or when they update. Metaproducts and platform products create new learning situations every time they add a new feature or transform into something new.

We have also examined how learning is becoming more important throughout the realm of product design. Consumers are demanding usability, and usability is tightly linked to learning. Everyday things are transforming into skill-based objects. And users are taking on new roles in the product development process, roles that require new knowledge and new learning.

Learning is a vital part of the user experience, and well-designed learning is a great way for us to differentiate our products from a crowded field of competitors.

Game Design + Product Design

Although their outcomes look very different, the processes of game design and product design have a lot in common. They are both creative endeavors. They can involve single artists or hundreds of people. They iterate and brainstorm. They perform market research and user testing.

As product designers, we use many of the same tools as game designers. We sketch, draw concept art, and create storyboards. We build models in the workshop and on the computer. We produce renderings and animations. When we reach production, we may use some of the same manufacturers. We may even produce products or games for the same clients.

In some areas, like consumer electronics, game design and product design are already highly interdependent. A team of in-house product designers develop an innovative new gaming console for an electronics company. A game design studio creates a game to play on it. Another group of product designers build a special controller designed especially for that game. Then more game designers build new games that take advantage of the new controller.

This section will focus on how games handle learning, and how game-learning is very similar to product-learning. There is a natural partnership here, and it can lead to some great user experiences.

"Joy of Use"

Game design and user-centered product design share an important goal. They both want to create good user experiences, not just beautiful artifacts. The ways they focus on user experience are so similar, it can be difficult to tell whether a designer is talking about games or products.

Here is Jesse Schell, a game designer, researcher and instructor at Carnegie Mellon University, describing the importance of experience design:

On their own, games are just artifacts -- clumps of cardboard, or bags of bits. Games are worthless unless people play them. Why is this? What magic happens when games are played?...When people play games, they have an experience. It is this experience that the designer cares about. Without the experience, the game is useless. (Schell, 2008)

When they create games, Schell encourages designers to ask three questions: "What experience do I want the player to have? What is essential to that experience? How can my game capture that essence?"

This may sound familiar to user-centered product designers. Jane Fulton Suri and Marion Buchenau encourage us to ask nearly the same questions: "What is the essence of the existing user experience? What are essential factors that our design should preserve?" (Buchenau & Suri, 2000)

Buchenau and Fulton Suri are talking about interactive systems, a class of software-based products that are very similar to games. But the same concept applies to nearly every kind of product. Steve Jobs explained his approach to product design by saying "... you've got to start with the customer experience and work backwards to the technology (Jobs, 1997)." And while Donald Norman did not use the words "user experience" when talking about why he appreciates some designs more than others, his sentiments are remarkably similar to Schell's:

Design is important to me, but which design I choose depends on the occasion, the context, and above all, my mood. These objects are more than utilitarian. As art, they lighten up my day. Perhaps more important, *each conveys a personal meaning* [emphasis added]: each has its own story. (D. A. Norman, 2007)

Our designs may be beautiful. They may be technological marvels too. But it is the personal connections that make them special. Interface designers sometimes refer to this as the "joy of use." Whether users are playing games, using everyday things, or working with professional tools, they are more successful and more satisfied when they use products that they enjoy (Hassenzahl, Beu, & Burmester, 2001).

Similar Challenges

Game design and product design share some of the same challenges too. Whether you are playing a game or using a product, most of your learning takes place in the domain of use. That means you learn by doing rather than by studying.

Similarly, both games and products rely mostly on procedural learning rather than declarative learning. There may be some benefit in being able to describe how to use your new lawn mower or bicycle, but being able to actually use them is much more important.

Finally, game designers and product designers are also absentee teachers. We are not there when users learn how to use our designs. All we can do is create hints, affordances and scenarios to guide them through the process.

This section will define each of these challenges. It will examine how designers address them and look for partnership opportunities between the two design disciplines.

Practice and Study

The actual process of developing product literacy is remarkably game-like. This section will explore the similarities between game learning and product learning in three steps. First we will establish the components of a good product learning experience. Then we will compare it to the principles of game learning. Finally we will look at a few examples of game learning in action.

I would like to categorize product learning into two parts. The first part is the collection of information, which I will call "study" from now on, and the second part is the practicing of skills, and I will refer to that as "practice".

I am not the first person to make this distinction. James Gee does something similar when he describes the dilemma between "telling", the giving of information, and "doing", the practicing of skills, in education (Gee, 2007).

Gee is primarily concerned with an educational environment, where teachers and students are both present. Teachers tell. Students do. In a product learning situation, there is usually only one actor: the user. So I have chosen actions that make sense in a one-person scenario. Hence the words "study" and "practice". They are both things that a single user can do.

Study is the accumulation of pure knowledge. It is what happens when you read the instructions for a product, watch a demonstration video, or sort through product reviews at an on-line retailer. Since you can study a product without actually holding it in your hands, study can be much more accessible, and less expensive, than practice.

It can also be risky. If the model you build in your head does not match the real world, then studying may make it more difficult to use a product. If you do not have enough general knowledge to form a mental model at all, then the information you gather may be confusing and easily forgotten (Gee, 2007). Even if you have a good mental model, the information may not be available when you need it (D. Norman, 1988).

Practice is experiential learning. We take actions and we observe the results. Then we adjust our approach. It can be guided, like when we work through a tutorial, or it can be completely experimental, like when we push random buttons on a display model in a store.

Without context, practice can be frustrating. Gee describes it this way: imagine a group of children with no math training. You give them some string and a lead weight. Then you ask them to discover Galileo's laws of the pendulum on their own. They are probably going to be frustrated. Most of them will need some information, like the principles of geometry, before they can understand what they are practicing. Until then, these young physicists are not developing much physics literacy, no matter how much they practice.

Meaningful practice can be a powerful learning tool. It anchors abstract information in the real world and makes it more memorable. It allows users to build more reliable mental models, which improves their studying, and encourages them to be more creative in the future. Most importantly, practice takes place in the domain of use. It provides immediate feedback that is directly relevant to the all-important question: "How well is the user using this product?"

For product designers, the goal is a skilled user. A product poet. One who understands what the product is saying, can tell the product exactly what they want it to do, and is confident in their ability to innovate and explore. This is an active goal. We measure success by how well a user performs, not by how much they know. So the most important learning takes place in the domain of practice, not the domain of study.

Here is an example. Sean Baker is an independent filmmaker. In 2015, he released a motion picture called *Tangerine*, "a decidedly modern Christmas tale told on the streets of L.A." (Magnolia Pictures, 2015). By most measures, the film is a success. It appeared in the Sundance Film Festival. Critics and audiences enjoyed it. Rotten Tomatoes, a website that tracks movie reviews across the

Internet, looked at 69 reviews of the movie. 65 of them were positive. Audience members rated it 3.9 out of 5 (Rotten Tomatoes, 2015).

Why is this interesting to product designers? Because Baker did not shoot *Tangerine* on professional movie-making equipment. He recorded it on the iPhone 5s (Newton, 2015).

We know Sean Baker and the members of his film crew are expert iPhone photographers. That is not because they recited a list of facts, or successfully described how to make movies on a phone — things that would demonstrate their abstract knowledge. It is because they did something remarkable. We can see their expertise in how well they *use* the product.

Does this mean that we can ignore study? No. Study gives shape to practice and provides goals. When an informed user takes a product out of the box, they may not know how to use it, but they do know what they want it to do. As they practice with the product, timely deliveries of useful information can keep them on the right track and point them towards new discoveries.

Gee describes three features of well-designed information that can be useful for product learning. It should be timely. It should be incremental. And it should be minimal. Timely information appears just as the user needs it. It matches the task at hand and it suits the user's skill level. Incremental is organized so that each lesson builds on the previous ones. Minimal information gives the user just enough to help them reach their goals, but it leaves plenty of room for discovery and experimentation.

What we end up with is an integrated form of learning that leans heavily towards practice. Users must do the heavy lifting themselves, but they are assisted by small doses of study. This is something that games do very well.

Smaller Worlds

To illustrate this hybrid style of learning, let us look at Magic Duels, an on-line version of the Magic: The Gathering card game. When new users open Magic Duels for the first time, they face two learning challenges: they have to navigate a virtual card table, where all of the familiar card-playing actions have been translated for a touchscreen. Then they have to learn the game itself.

Learning Magic Duels is a bit like learning a smart gadget. They both start with simple platforms. For Magic Duels, the platform is the basic rules of the game. For a gadget, it is the operating system.

These platforms are simple, easy to learn and a little bit dull. They do not reach their full potential until you add things to them.

Gadget users add apps to their products. Magic players add cards. Some cards stick to the basic platform, but many have their own special rules and exemptions. They can change almost anything about the game: when you play a card, how you play a card, what cards do when you play them. When the right cards are played together, they can change the game completely.

Magic: the Gathering is more than 20 years old. It has seen dozens of expansions and includes thousands of different cards. The possible combinations of unique cards and special rules are nearly infinite, and novices may face 20-year veterans on the other side of the virtual table. It is a game that demands a good learning experience. Without it, new users will be overwhelmed.

How does Magic Duels introduce such an intimidating game? They start by shrinking it down to a manageable size. Instead of facing off against other human players, what the game calls "Battle Mode", new users are directed to "Story Mode". There they play a limited version of the game against computer-controlled opponents. And all of it is wrapped up in a story that gives players the information they need, exactly when they need it.

Gee calls this "The Subset Principle" (Gee, 2007). Users take their first steps in a simplified version of the larger game. Then, as their literacy develops they gradually step into the larger world.

Story mode starts with a series of "Skill Quests" that introduce the basics of the game. Cards are already on the table, as if a game was already in progress, and a narrator walks the new player through the game's layout and vocabulary. The shuffled deck of cards, called "the library", goes here. Discards go here. Here is your hand. Here the cards you've already played. Here is how you examine a specific card. Here is how you move it from your hand to the table.

Each quest introduces a new mechanic. You learn how to attack your opponent and how to defend yourself from attack. You learn to build your armies and banish your opponents' minions. After the narrator explains each one, she says "To complete this skill quest, finish off your opponent this turn." Then you must put what you learned into practice.

Soon you are participating in full games against computer controlled opponents. The action is always limited to what you already know, plus one or two new additions. One game includes flying creatures, which cannot be blocked by earth-bound cards. Another adds special enchantments that can make other cards stronger. Each mechanic is accompanied by a quick skill quest, then you apply what you learned in an actual match.

Winning a match in Story Mode earns gold coins, just like winning a match in Battle Mode. Once you finish the tutorial, you can spend these coins to buy "booster packs" of cards. Then you can use the new cards to make yourself more powerful. These rewards are an incentive to play through the tutorial, but they also tie the tutorial to the rest of the game. Even though they are just starting out, players are still earning real game rewards: something that they can use when they move into the larger game.

When you finish story mode, you have experienced all of the core rules and mechanics. You've practiced some basic strategies. Plus you've had a chance to play with, and against, all of the major factions in the game. You are not an expert yet. That will take more practice. But you are functionally literate.

You will also have a starter deck of cards, plus enough gold coins to buy a booster pack. That gives you enough cards to compete in Battle Mode, plus a few extra to customize your strategy.

This kind of immersive introduction is a common feature in video games, whether they involve epic magical duels, building a city, or managing a diner. Most of them have five key features:

- They take place in a small, easy-to-understand subset of the game. All of the important mechanics are present, but most of the distractions are not.
- They focus on practice rather than study. The user is an active participant who operates the game exactly as they would in real life. When study is necessary, it is timely, incremental and minimal.
- They start the user off with a win. The user knows what success looks like and they know they can achieve it.
- They offer real rewards. The user can bring their successes with them when they enter the rest of the game. This makes the tutorial relevant to the user, instead of an obstacle they have to overcome before they start using the product.
- They develop basic literacy. When they finish a tutorial, the user can read the game. They can operate the controls. And they can devise strategies to deal with new challenges.

The first time someone uses a product is dangerous. A bad initial learning experience can create a poor impression of a product's usability. That leads to dissatisfaction, abandoned gadgets, and returned products (Billeter et al., 2011; Mack & Sharples, 2009). The designers of Magic Duels have addressed this challenge by building a safe space for new users. It integrates smoothly with the rest of the game and gives the user all the tools they need to survive.

Some consumer products already offer this kind of learning experience, but most of them fall short. Lists of features and passive slide shows give the user information, but they do not allow the user to practice. Canned tutorials isolate the user from the real world, forcing them to practice on irrelevant projects instead of working their way through real ones. Incomplete instructions show users how to perform a few tasks, but they stop short of basic literacy. The new user experience is an area where we have a lot to learn from game design.

Designed to Be Difficult

What happens when new users are not so new anymore? You cannot lock them in a miniaturized world forever.

Games are designed to be difficult. They are the quintessential skill-based product. As long as the user keeps playing, they are going to keep learning new things. The game gives them a challenge. They try one approach. They try another. Then they solve it! So the game gives them another, slightly more difficult challenge. Every time they deal with a new problem, they learn something new (Gee, 2007).

Products are a little bit different. Designers want things to go smoothly. We do not create new challenges when users overcome the old ones. At least we try not to. Instead, users create new challenges themselves. They change the functionality of their products by adding apps or accessories. They try new things and bring their products into new situations.

The process looks very game-like. Users learn to use a product. They seek out a new challenge, and they learn to overcome it. Then they seek out another hew challenge. Eventually, they are making feature films on their smartphones.

Just like the new user experience, most game learning emphasizes practice over study. It is an active form of learning that looks surprisingly like the scientific method (Gee, 2007). Players encounter a problem. They develop a hypothesis and they test it against the problem. Then they reflect on the results. If they are successful, they save what they learned for the future. If they are not, they develop a new hypothesis and try again.

Guild Wars 2 vs. Rebel XS

Let us compare a game and a skill-based product. In this case Guild Wars 2 and the Canon EOS Rebel XS, a digital single-lens reflex (DSLR) camera.

Guild wars 2 is a MMO, or "massively multi-player online" game. That means there are thousands of people sharing the same game world. Many of the characters that you meet in the game are controlled by players rather than the computer. It takes place in a fantasy setting, with magic, mythical creatures, and epic "save the world" storylines. As the name suggests, Guild Wars 2 involves a lot of fighting. But there are other options too, like solving puzzles, exploring a large open-ended world, and interacting with friends.

For this comparison I started the game over with brand new character. We will call him Klobbins, the level 1 warrior. As Klobbins develops from a novice to a seasoned veteran, we will talk about what that means for a player.

Like many MMOs, Guild Wars 2 rates characters according to their abilities. A level 1 character, like Klobbins, is not very impressive. He starts with a suit of tarnished armor and a dull sword. He has one weapon skill, a basic attack that he can use to damage his opponents, and one healing skill which will help him recover from the damage he receives during his adventures. He's also restricted to a single location: a small outpost where he and his friends are under attack by a group of mad scientists and their robotic minions.

Fortunately, the scientists and minions are also level 1, and Klobbins has the tools he needs to defeat them. He has completed his fist mission!

Every time Klobbins completes a task, he receives experience points. When he collects enough experience points, he will graduate to level 2, then level 3, and so on. Each level unlocks new abilities and new challenges. Level 2, for example, rewards Klobbins with a new sword and gives him a second weapon skill. It also moves him from the small outpost to the wider game world, where there is more to explore and the opponents are fiercer.

If you read the last section, you might recognize this as a classic new user experience. It is a limited subset of the game, where players face manageable challenges and learn the basic mechanics. It starts them off with a meaningful success, rewards them with something they can use in the future, and sends them out to explore the rest of the game.

Armed with his new sword and his two weapon skills, Klobbins ventures out into the world. He completes more missions. He solves puzzles. He discovers new territory. Some new challenges are more than he can handle, but with practice and experimentation he learns how to defeat them.

As Klobbins advances, he receives more experience points, earns more levels and unlocks new things. At level 6 he learns how to gather raw materials, like wood, cloth and metal ore. At level 12 he learns how to craft them into new gear. At level 22 he discovers "The Heart of the Mists," a special zone where he can fight against other players instead of computer-controlled opponents. Level 30 introduces him to "dungeons," where the monsters are so deadly they can only be defeated by several players working together. Along the way, he upgrades his equipment, learns new skills and discovers new ways to customize his abilities.

This leveling process is like an extended new user experience. Klobbins's still operating in a subset of the game, but that subset gets bigger every time he gains a new level and unlocks something new. Slowly introducing new features can be helpful, because Klobbins is a complex system all by himself. By the time he finishes leveling he will have access to 91 active skills: abilities that do something specific when you press a button, like swing a sword, parry an opponent's attack, or repair damage. He can modify these skills, making them stronger or adding special side effects, by using 60 different passive traits, 25 varieties of equipment, and more than 150 enhancements: special runes and sigils that you apply to your equipment. By dishing them out a few at a time, the game gives me a chance to learn how each feature works before it gives me something new to learn.

The leveling stops at 80. That does not mean that Klobbins has defeated every challenge in the game. In fact, a new level 80 probably hasn't seen most of the game yet. But he has unlocked all of his tools. Now the focus shifts from "what new ability does my character have now?" to "what can I do with all of these abilities?"

At this point, many players pick a facet of the game and customize their character so he is really good at it. All of the character's skills, traits, gear and enhancements are aimed at a specific goal. And there are a lot of different goals to choose from, such as dungeons, world exploration, or player-vs-player combat (in small groups or large). It may take a player several months, and several different configurations, to complete everything.

The Canon EOS Rebel XS is a DSLR camera. If you are not familiar with photography, that is a digital camera with interchangeable lenses and a lot of user-adjustable settings. It is similar to the film SLR cameras that photographers have used since the 1950s, but it is smarter. You can adjust all of the settings manually, or you can set it to automatic mode and let the camera adjust things for you. It is also faster. Users can see their images and make adjustments immediately, instead of waiting for film to develop.

The Rebel XS is not a game. It is a real-world product, and there are obvious differences. There are no scripts, and designers have much less control over how people use their products. A game designer can force every new user into a limited scenario for their first learning experience. A product designer cannot, but that does not mean that they cannot take advantage of Gee's subset principle.

DSLR cameras have something that is almost as good as a new-user tutorial. They have the automatic mode. If users start by letting the camera make most of the decisions for them, and introduce a few new controls at a time, they get a learning experience that is very close to leveling in Guild Wars 2.

Since digital cameras include small computers, it is possible that designers could build a step-by-step learning program based on the automatic mode. But the Rebel XS' designers did not. To me, this is a missed opportunity. Any product that has automatic and manual modes already has the foundation for a rich learning experience. We just have to build upon it.

Experimental Learning

Once users learn the basics, Guild Wars 2 and digital photography learning experiences converge. Both experiences involve complex systems with a lot changeable parts. Small changes to one part can have large effects on the end result.

In order to become experts, users must learn how to manipulate the entire system in a variety of challenging situations. Most of the time, they do this by working within the system, but they can also make changes to the system itself (Zimmerman, 2008).

In Guild Wars 2, I can work within the system by choosing specific skills and traits for my character, equipping different kinds of gear, and modifying it with a variety of runes and sigils. I can change the system itself by upgrading my computer so the game runs faster. I can buy special peripherals, like high-resolution, multi-button mice or programmable gaming pads. I can change the settings on my monitor so I can see hidden objects more easily. I can even, if I have the expertise and inclination, hack the game or use macros to improve my performance.

I can do similar things while I am taking photos. I can work within the system by adjusting the settings of my camera. Or I can change the system itself by adding external lighting, building sets, smearing things on the lens, or altering the image files in Photoshop.

There are several places to learn these strategies. They may appear online, or in a book. They may be passed from user to user. But most of them are learned through experimentation.

Last year I joined a group of friends in "The Foefire Cleansing," an encounter in Guild Wars 2. We had finished the encounter before, but this time we wanted to earn a special achievement. If we could complete the encounter without getting hit by "spectral flames", a hazard which pops up several times during the encounter, we would earn the "Sandford Family Ring," a rare magic item.

It took us several attempts and more than two hours to reach our goal. Our characters were well-equipped to defeat our foes, but we had trouble avoiding the flames. What if one player climbs on this pile of rubble? They'll be above most of our opponents, and might be out of reach of the spectral flames. That did not work? It did not seem like the flames ever reached that corner of the room, what if someone stands there instead?

Our solution was complicated, but it worked. One person stood in the corner. Two more people ran around the other side of the room, to distract the spectral flames. If a flame got past the distraction, a fourth player would intercept it before it could reach the person in the corner. Everyone got hit by several spectral flames, except the person in the corner. So we ran the encounter several times, and gave each person a turn in the safe zone. When we were through, everyone had earned the achievement and received their ring.

Gee calls this "probing." We found a challenge. We tried several different strategies. After each attempt we regrouped and evaluated our results. Then we tried something new, over and over until we found the right one.

Taking a picture works the same way. Each situation has its own challenges and it usually takes a few experimental photos to get things right. You take a picture. You look at it on the screen, or on a computer. You adjust your camera. If the setup allows it, you may move the subject or adjust the lights. Then you repeat the process until you are satisfied with the results.

In both cases, experimental learning is an important part of the user experience. How can we encourage our users to do the same thing with our products?

What Video Games Have to Teach Us About Learning and Literacy offers two interesting solutions: provide multiple routes to success and ensure that users are rewarded for their efforts.

The multiple routes principle says that there are many different paths to success. Users can choose their path, based on their skills and preferences. Our solution for the Foefire Cleansing, for example, was not the only way to complete that achievement. Other users found their own solutions (Dulfy, 2014). They discovered their own safe spots. They experimented with different numbers of players. They tricked the game's artificial intelligence. As long as they avoided the spectral flames, they all earned the same reward.

Game designers have some control over the flexibility of their games (Schell, 2008), but in the real world, the multiple routes principle is unavoidable. Imagine you are having a night out with a group of friends. You want to take a picture of everyone, but the lighting is dim. How do you solve the problem? One person will use a flash. Another person will adjust the shutter speed, aperture and ISO settings on their camera. Someone else will say, "Let's go over here. There is more light." A fourth person will take the picture as-is, then edit it with Instagram or Photoshop.

Different solutions depend on different skills and preferences. The person who uses a flash may not know how to adjust the ISO settings on their camera. The person who edits the photo in Instagram may want an underexposed retro image. Designers cannot plan for all of these solutions, but we can encourage experimentation and accommodate a wide range of user skills and preferences.

Part of accommodating different skill levels and preferences is making sure that every user is rewarded for their efforts. In the Foefire Cleansing, we were rewarded with a magic ring that could make our characters stronger. We also received a handful of "achievement points." Achievement points are a prestige item. Guild Wars 2 players use them to keep score. The more points you have, the more things you have accomplished in the game. You can even view the world-wide leaders' scores on the Guild Wars 2 website (Arenanet, 2015).

Achievement points also grant access to exclusive "skins," cosmetic items that change the way a character's equipment looks. So, by completing the achievement in the Foefire Cleansing, we were increasing our characters' power, making our characters look good in the game, and earning bragging rights.

Can a camera do the same thing? Yes and no. As a user centered designer, I am not comfortable with magic rings. I want users to be at full strength as soon as they pick up my products. I do not want to force them to earn product features. Those features should be available to anyone who has the knowledge. So magic rings are out.

But achievement points, or anything else that lets users measure their success and make themselves look good, are a great idea. In photography, these rewards already exist. They just exist outside of the camera itself. Instagram, Facebook and other online services allow users to share their work, earn points (or likes), and compare their results with other photographers'. They can also show users what is possible, and encourage them to seek out new challenges. That leads to more experimentation, more learning and better literacy.

Remote-control Education

Game designers and product designers are remote-control educators. We do not personally teach users how to operate our products. The best we can do is pack as much useful information into our products as we can before they roll out the door.

Most of the elements of good teaching are beyond us. We cannot get to know our students. We cannot provide personal feedback or encouragement. We cannot limit distractions or provide a safe space for learning.

We do have a powerful teaching tool: material intelligence. Donald Norman calls it "knowledge in the world" (D. Norman, 1988), but I really like James Gee's explanation:

Thinking, problem solving, and knowledge are 'stored' in tools, technologies, material objects, and the environment. This frees learners to engage their minds with other things while combining the results of their own thinking with the knowledge stored in these tools, technologies, material objects and the environments to achieve yet more powerful effects. (Gee, 2007)

Tools? Technologies? Material objects? Environments? That is what designers do! We do not just use tools, technologies, material objects and environments, we make them. In many cases, we decide everything about them: what they do; how they interact with users; how they look; how they are made; what they are made of. We may not be able to work with users face to face, but we own material intelligence.

Material intelligence is deeply entangled with affordances. It either tells us what affordances exist, or it uses affordances to guide us towards a desirable behavior. As an example, look at your computer's keyboard. The symbol on each key communicates an affordance. Using the A key affords entering the letter A. I call this a "signpost".

How do you use the A key? You press it. The key's affordances guide you towards pressing. Pulling the key is difficult. So is twisting it or pushing it from side to side. But pressing it is easy. The desirable action is the easiest path. I call these types of material intelligence "fences" and "paths". Remember the garden analogy I used when we discussed affordances at the beginning of this thesis? Affordances that guide you towards an action are paths. Affordances that guide you away from an action are fences.

Signposts

A good signpost is clear. It shows users that an affordance exists and tells them what it does. It is also reliable. Users can trust that what it tells them is true.

Affordances operate outside of perception (Gibson, 2014). They exist whether a user knows they exist or not. But perception still plays an important role in how affordances affect users.

When he discusses the relationship between affordances and perception, designer and researcher William Gaver (1991) asks two questions: Does an affordance exist? And is the perceived information true? If the answer to both questions is "yes" than the relationship is a "perceived affordance." Users can see the affordance and act accordingly. If both answers are "no", then this is a "correct rejection". No affordance exists and there is nothing to encourage users to act as if it does. In both cases, the perceived affordances lead users to take appropriate action. For the sake of this discussion, I will call both of these relationships "true affordances".

If the answers do not match, then they create problems for the user. When affordances exist but the perceived information is false, Gaver calls the relationship a "hidden affordance." Even though a user could take action or experience an unintentional effect, there is nothing to tell them that the action or effect is possible. Alternately, if the answers are reversed, so perception tells users that an affordance exists even when it does not, then users are encouraged to attempt the impossible. This situation is a "false affordance".

Both of these situations can be frustrating, or even dangerous. If a hidden affordance conceals a product's function from a user, then they are unable to use it fully. This problem is dismayingly common in software design, where options may be buried under several layers of menus or disguised with confusing icons or unfamiliar jargon.

Hidden affordances can also conceal undesirable things. Press the wrong, unlabeled function key on your computer and you may delete an important file. On a kitchen stove, the perceived affordance may say "This surface is safely touchable" even though it is scaldingly hot. In a game, right click on the wrong character, and you may set off a trap, start a small war, or attack a completely innocent person. Without the aid of correct information, users can put their work, their environment, or themselves in danger.

Here is a simple example from Star Wars: The Old Republic, another MMO, created by BioWare in 2011.

In the Star Wars: The Old Republic, computer-controlled opponents come in four flavors: weak, standard, strong and elite, each one a little more powerful and a lot more durable than the last. An opponent's type is clearly marked with an icon next to the name plate that floats above its head, descriptive text, and an increasingly elaborate frame that surrounds its picture in the player interface. In the images below, we can see that the Geonosian Drone Champion is a strong opponent, thanks to the signposts we see on the screen.

Figure 2: Geonosian Drone Champion (Picture Frame)

Figure 3: Geonosian Drone Champion (Icon)

If Star Wars: The Old Republic was a movie, weak and standard opponents would be extras the main characters fight *en-route* to the main villain. Players can defeat them in seconds with two or three quick attacks. Strong and elite opponents are tougher. They hit harder, absorb more damage and frequently come with special abilities that incapacitate their opponents or deal extra damage. These are the featured fights of an encounter, where the hero squares off against a dangerous foe and the outcome is not quite certain.

When players square off against a group of opponents, like a swarm of Geonosians, they may face several different types of foes at once. So assessing threats and choosing targets quickly can be very important. Players could do this by carefully analyzing how much damage each foe deals with each attack, or by timing how quickly each one falls to a barrage of blaster fire. But in the middle of a big action scene there is not time for that kind of research. So, just like a typist relies on the knowledge stored in a computer keyboard, players rely on the knowledge stored in icons and picture frames. That allows them to assess threats and choose their targets with speed and confidence.

"Let's Play Huttball!"

Now let us look at how groups of signposts work together to help users navigate a difficult, and highly-stressful, learning situation. Once again, we are in Star Wars: The Old Republic. This is the Pit, home of the "Huttball" Warzone. Players come to this location when they want to participate in player vs. player competition.

Figure 4: The Huttball Arena

At its core, Huttball resembles rugby or American football. Each team tries to carry the ball into the opposing team's end zone. While the offense runs with the ball (very slowly, the ball comes with a substantial speed "debuff", a penalty that reduces the carrier's movement rate) or passes it between teammates, the defense tries to defeat the ball carrier and intercept the passes. If the ball carrier falls, the ball flies to a nearby opponent.

In some situations, after a character scores or when the ball carrier falls with no one nearby, the Huttball vanishes. Then the announcer calls "Neutral Ball!" and the ball reappears at the center of the field. Any player can pick it up and begin the attack again.

Unlike football, Huttball comes with blaster pistols, grenades, rocket launchers and light sabers. Whoever holds the ball must weather the combined (and sometimes highly-coordinated) aggression of eight heavily armed defenders who want to defeat the ball carrier before they reach the end zone. I have been in this situation, and it is a little like setting off the grand finale of a fireworks display in the middle of a crowded dance club: so many flashing lights, moving bodies and explosions that it is hard to process anything.

But the ball carriers are not alone. They have seven teammates to offer protection and disable attackers with their own volleys of rockets, laser beams and light sabers. This is a mixed blessing. It is nice to have support from your team. But that support adds to the chaos surrounding the ball carrier.

The Huttball arena does not make this any easier. Unlike football, which is played on a smooth, level field, Huttball is played on an obstacle course. There are terraces, catwalks and deadly traps. Bursts of wind hurl characters in unexpected directions. Flame jets in the floor threaten to burn them to a crisp. No matter where a character stands, it is impossible to see the entire arena, and there is rarely a straight path between the character and their destination.

In the midst of all this chaos, players have to learn the rules of the game and the specific details of each match. Who's on my team? Who has the ball? Where is the end zone? Where should I run? Where are my teammates? And where are those rockets coming from?

It is easy to become confused. Fortunately, the game offers several signposts to help players learn.

Take a look at the image below. The avatar in the center of the screen is "Hench," a character I created as part of this thesis. In this situation, my team, "The Frog-Dogs", have the ball. We have escaped the dance party and we are running along a catwalk near the opposing team's end zone.

Figure 5: The Huttball Arena (End Zone)

The signposts in this image answer several of the questions I asked above:

Who's on My Team?

Near the center of the screen, you can see a character in a yellow costume. Her name appears in green above her head, which tells me she is on my team. This is reinforced by looking at the scoreboard in the upper right-hand corner, where the words "Your Team" are written in the same font and color.

From this position, I can see two other players with red names floating above their heads. Looking at the scoreboard again, I see that the words "Enemy Team" are written in red. I can safely assume that those red-named characters are opponents.

Who Has the Ball?

A silver ball surrounded by a blue glow floats just below my teammate's name (it is partially hidden by two black and green progress bars, signposts that tell me about her level of health and her resistance to certain enemy attacks). That is the Huttball. Since it is floating above her, I know that she is the ball carrier. But that tiny sphere can be tough to see, so the designers added a yellow column of light above her head. That column goes all the way to the ceiling and can be seen at any distance, so players all over the Pit can find her.

Once again, the scoreboard in the upper right-hand corner of the screen gives us additional information. To the right of the Frog-Dog logo, we can see a round yellow icon that resembles the Huttball. It is on our side of the scoreboard and it is yellow (the Frog-Dog team color), which tells everyone that the Frog-Dogs have the ball.

Where Should I Run?

There is a wide purple stripe ahead of us. That is the Rotworms' (the opposing team) end zone. If we carry the ball into their end zone, we score! We know it is the Rotworms' end zone, because it is purple, the Rotworms' team color.

Fences and Paths

Sometimes we dispense with learning and simply force users down a certain path. There can be good reasons to do this. Maybe a specific action is unsafe, and we want to prevent injury. This is why the power tools in my workshop will not operate unless safety features are engaged. Or maybe we want to eliminate the amount of mental effort it takes to operate a product. The light switch I mentioned earlier is a good example. You do not want to waste time or energy analyzing the system, so the switch limits your options.

For the sake of learning, designers may also take a middle path. They do not limit all options, they just limit a lot of them. It is like the subset principle. When you have fewer distractions, you can focus on the important things.

Let us take another look at Huttball. Most of the players in the Pit have two types of abilities: attacks, which they use to harm their opponents, and defenses, which they use to help their friends. Hench, for example, can blast opponents with his assault cannon or heal his teammates with medical probes.

In a "realistic" game (or as realistic as a game with droids and Jedi can be) Hench would have to pick his target, decide if it was a friend or a foe, and then decide whether he was going to blast it or heal it. That is a lot to process in the middle of a Huttball match. So the game limits his options. He still has to pick his targets, but he does not have to decide if they are friendly. Offensive skills will only work on opponents, and healing skills will only work on friends. So Hench never needs to worry about accidentally shooting a friend or healing an opponent. He does not have to learn it. It just happens. So he can focus his attention on other things.

What does this mean when we are talking about signposts, fences and paths? In this case, the signposts that distinguish friend from foe do not matter. Fences block Hench from using the wrong skills on the wrong targets. And paths allow him to use the right skills on the right targets.

"The Peppermint Twist"

To show you how fences, paths and signposts work in the real world, I am going to tell you a scary story. This comes from *Set Phasers on Stun*, written by Steven Casey (1998). When I was an undergraduate, Casey's books were required reading for every industrial design student, and many of us referred to them as "design horror stories". They contain carefully-researched, and frequently lurid, descriptions of design gone wrong. So be warned, this is not a comfortable story.

A crowded club in Topeka Kansas, called the Peppermint Twist, serves "watermelon shots" as its nightly special. Because the club is very busy and the drinks are popular, the bartender mixes them in batches and stores them in a bottle on the bar, where the servers pour them into glasses and deliver them *en masse* to the club's patrons. The watermelon shots are pink, like candy. Their consistency is thick and syrupy. They are mixed by the bartender and stored in a distinct bottle on the bar. They are served in drinking glasses and delivered by the wait staff. These stimuli combine to create a perceived affordance: "watermelon shots are drinkable."

The club itself provides more supporting signs. The bar itself tells users that "the liquids created here are drinkable". The tables say "liquids served here are drinkable". Patrons are surrounded by other people drinking watermelon shots and modeling the affordance that "watermelon shots are drinkable." The familiar "order a drink, receive a drink, and pay for a drink" interaction between patrons and the club's staff reinforces the perception. Fortunately, "watermelon shots are drinkable" is a true affordance. When a patron drinks a watermelon shot, they get exactly what they expect. But if the signs change, especially if the perceived affordances and physical affordances no longer match up, then the situation can become dangerous.

Lurking in the Peppermint Twist's kitchen is a five-gallon bucket of Eco-Klene, another liquid with superficial similarities to watermelon shots. Like watermelon shots, Eco-Klene is pink and it has a thick consistency. But Eco-Klene is a lye-based caustic cleaning solution for industrial dishwashing machines. In its undiluted form, it contains enough lye to cause serious chemical burns. Needless to say, its physical affordance is "undrinkable".

When it is stored properly, Eco-Klene is well protected by fences and signposts. Its tight-lidded 5-gallon bucket is difficult to lift and sports bright red warning labels. It is kept in the back of the kitchen, well away from the bar and surrounded by unappetizing things, like dirty dishes, washcloths and sponges. Patrons are unlikely to encounter it at all. If they do, they will not mistake it for a beverage. But tonight trouble arises when the employees of the Peppermint Twist strip away all of those protections. First, the bartender runs out of ordinary dish soap for the bar sink and he cannot find a replacement. Instead of running to the store, he opens the bucket of Eco-Klene and pours some of it into a bottle. This disables all of the protective material intelligence provided by Eco-Klene's packaging and location. The bottle has no warning labels. It is easy to carry. It can be moved, with minimal effort, away from the dirty dishes, wash cloths and sponges. It can even be carried into the bar, where it can acquire an entirely new, and completely misleading perceived affordance.

And that is what happens. Separated from its original context, the bottle of pink, creamy Eco-Klene is nearly indistinguishable from a bottle of watermelon shots. Now the same signs: the bartender, the waitstaff, the modeling by other patrons, that gave watermelon shots their true "this is drinkable" affordance, conspires to mislead patrons and staff about the drinkability of Eco-Klene. Shortly after the bottle is placed on the bar, a server mistakes it for a bottle of watermelon shots. She pours the caustic cleaning solution into glasses and delivers them to three club patrons. Following the behavior modeled by the people around them, these patrons drink their Eco-Klene shots in one quick gulp and suffer serious, permanent injury.

Let us compare the Peppermint Twist and the Pit. Both of them use affordances to shape users' behavior. The Pit does not let players shoot their friends or heal their opponents. If you target a friend and try to shoot them, nothing happens. If you throw a grenade and it lands next to your friend, it will explode. It will still harm any enemy who happen to be next to your friend, but your friend will not be damaged. You can even shoot through a friend to hit an opponent on the other side. You friend will not be harmed. This affordance is iron-clad. In Star Wars: The Old Republic, friends are absolutely unshootable.

The owners of the Peppermint Twist and Ecolab, the makers of Eco-Klene, might be jealous. They tried to set up their own iron-clad affordances. They put the caustic cleaning solution in a five-gallon bucket that was heavy and difficult to pour. They sealed the lid. They put it in the back of the kitchen a place where bar patrons do not usually venture. If patrons do, they are encouraged to leave. If we could read their minds, we might have seen "Eco-Klene is undrinkable," written in large, confident letters. Then they were defeated by a bartender and a dispenser bottle.

Game affordances and product affordances are not quite the same thing. Game designers have godlike power over their creations. Within the game, they can literally shape reality. Product designers cannot. They can build paths and put up fences, but they are at the mercy of their users' creativity and determination.

Despite this difference, game designers and product designers use affordances the same way. They make desirable behavior easier and undesirable behavior more difficult. This common ground is its own affordance. It means that many game learning principles are usable in the domain of product design.

Other Tools

Signposts and fences are not the only remote-control teaching tools we have. They are just my favorites. The ways that they are used in game design and product design are so similar that they provide an easy bridge between the two disciplines. Now I would like to examine two game design tools that are a little different: feedback and affinity groups.

Product designers love feedback. It is something that we use very well. But I think games still have some interesting things to teach us, especially about using feedback to make users feel powerful.

Affinity groups, on the other hand, may be unfamiliar to most designers. With the help of other people, users are achieving remarkable levels of literacy and creativity. We do not have much control over how affinity groups, which can be terrifying for designers. But if we recognize them and give them room to work, they can be great allies and surrogate instructors.

Feedback

Feedback is already an important part of user-centered product design. Donald Norman compares it to hearing the sound of your own voice, and imagines what a conversation would be like if you could not be certain of what you are saying (D. Norman, 1988). He also lavishes praise on Bell Telephone during the height of their US telecommunications monopoly:

> The push buttons were designed to give an appropriate feel--tactile feedback. When a button was pushed, a tone was fed back into the earpiece so the user could tell that the button had been properly pushed. When the phone call was being connected, clicks, tones, and other noises gave the user feedback about the progress of the call. And the speaker's voice was always fed back

> into the earpiece in a carefully controlled amount, because auditory feedback (called 'sidetone') helped the person regulate how loudly to talk. (D. Norman, 1988)

Game designers also place a high value on feedback. They use it to communicate with users and to help users evaluate their performance, but they also use it to create a sense of satisfaction and reward. Jesse Schell is a game designer, but he illustrates the value of feedback by talking about sweeping the floor:

> Unless a floor is really dirty, it's hard to tell whether your sweeping is making any difference just by looking at the floor...this lack of feedback can make the entire task feel somewhat futile, which means the user enjoys it less, and will clean their floor less often. In other words, less feedback=dirtier floor. (Schell, 2008)

Feedback, according to Schell, "provides concrete evidence of a job well done."

James Gee argues that feedback should not just be clear, timely and rewarding. It should also amplify the user's actions (Gee, 2007). A small press of a button should have a large effect. It should make the entire virtual world come alive. I would argue that, when it is possible, using a product should do the same thing.

Let us revisit Guild Wars 2 and Klobbins, the Level 1 Warrior. When Klobbins uses a skill, when for instance he attacks one of the robots that are invading his village, several things happen. The character leaps, literally leaps, into action. He swings his sword so hard it lifts him off the ground. He grunts and shouts. If his attack hits, we hear the impact and the robot squeals in alarm. A number, indicating the amount of damage Klobbins has dealt, appears above its head and floats into the sky. We see a large chunk disappear from the robots health bar. A few more hits and the robot falls apart at Klobbins' feet. The whole thing is exaggerated and a little bit silly, but it also provides rich, multimodal feedback and rewards.

Jane McGonigal calls this kind of zany, dramatic feedback "a vivid demonstration of the players' agency in the game" (McGonigal, 2011). The feedback is not just telling the player that she pushed a button, it is telling them that their actions are powerful and important. "When we're reminded of our own agency in such a positive way," she concludes, "it's almost impossible not to feel optimistic."

This shared focus on feedback provides a natural bridge between product design and game design. It also provides examples of how to use the principles of game design to provide a better product learning experience.

Affinity Groups

Like affordances, feedback is embedded in product design. It has been in our toolbox for decades. Interest groups, on the other hand, are an emerging tool.

As the name suggests, interest groups are united by a common interest, like music, industrial design or gaming. They are not new. I have been singing in choirs (a musical interest group) for most of my life. For that matter, my grandfather did the same thing for most of his. We have been gathering with like-minded people since we were people.

Social networking makes this easier than ever. Some activities, like photography, are the beneficiaries of billion-dollar apps and websites. Even the smallest interest group can find a home on Facebook or Reddit.

Nearly any interest group can be a useful learning tool, but passionate affinity groups are the gold standard. James Gee and Elisabeth Hayes list fifteen characteristics that separate affinity groups from other interest-oriented communities (Gee & Hayes, 2010). Their research is focused on the intersection between game design and education, and therefore many of these characteristics fit most comfortably into that domain. But there are several that also work well for product design and user learning.

As an interest-oriented community, an affinity group is built around "a common passion-filled endeavor." A gaming group might focus on a specific game, like the Sims, or even a specific part of a game, like modifying the code to build new environments, objects or features. Members participate because they enjoy an activity, and most of their interactions are based on that activity. In fact, they may not know anything about the other members except that they share a common passion.

They educate their members. Affinity groups are storehouses of information. They discuss projects. They post pictures. They offer feedback. They link to other useful sites. But no one is educated against their will. Everyone is responsible for their own learning.

Every member of the community can be a student and a teacher. When they want information, users can ask questions, find tutorials, look at examples and read articles. If the group's interest is digital, they may even be able to download useful apps and data. But they can provide information too. The community allows them to answer questions, create tutorials, provide their own examples and upload files.

They put learning into action. The assumption behind all this information is that people are going to use it to do something. Members are encouraged to share their successes (often with step-by-step instructions, diagrams and materials lists). Questions, answers and tutorials are action-oriented, like "How do you open the treasure chest at the end of Scavenger's Chasm?" or "What's the fastest way to reach level 80 with a warrior?" Depending on the interest, they may even offer ways for users to collaborate on group projects.

During their research, Gee and Hayes interviewed Tabby Lou (or "TabbyLou" when she is online), a 61 year-old retiree and an avid Sims 2 modder. Tabby Lou became interested in the Sims through her grandchildren and started designing new objects for the game when her granddaughter asked her for a "purple potty" to put in her virtual house's bathroom.

The Sims 2 did not come with a purple potty, so Tabby Lou learned how to make one herself. Along the way she connected with an affinity group of Sims modders and developed an impressive set of digital skills. She also became a prolific and well-known Sims 2 designer. According to her personal page at thesimsresource.com, one of the affinity groups that Tabby Lou calls home, she has created 9,307 objects for the Sims 2. They have been downloaded more than seventeen million times (The Sims Resource, 2015).

Tabby Lou has the ideal affinity group story. She wanted to learn something. She found an online community that could help. At first she was just a learner, but as her skills developed she started helping other users. Once she became an expert, she stayed in the community, where she provided tools for other Sims 2 enthusiasts and got help from other users when she needed it.

This kind of nurturing community is great for users and user learning. Gee and Hayes describe it this way:

> ...it helps to have a community behind you. It helps even more when that community allows people to help and be helped, to mentor and be mentored, to lead and be led. It helps, too, when that community is a community of true professionals (pro-ams in this case) who use praise, support, and encouragement to spread their passion. (Gee & Hayes, 2010)

Nurturing communities do not just help users. They help designers and businesses too. First and foremost, they add valuable things to the product. Tabby Lou, for example, has added more than 9,000 objects to the Sims 2. Users like her work so much that they have downloaded it millions of times.

Affinity groups can also fill the mentorship gap. We may not be able to guide users through the learning process, but affinity groups can.

There are some great examples of affinity groups in the domain of product design. The community of IKEA furniture modders, which I mentioned earlier in this thesis, are one. Designers and businesses do not always know what to do with them. IKEA, for example, once threatened legal action against IKEAhackers.net on the grounds that the site was abusing IKEA's intellectual property (Wilson, 2014). But when we work with affinity groups, or even just allow them to flourish on their own, we turn some of our biggest fans into useful partners.

Biomimicry and Ludomimicry

What does a game design/product design partnership look like? There are not any established processes. There are not even many examples, especially in the realm of physical products.

Biomimicry may provide a good model. It is another interdisciplinary partnership, one that combines design and biology, and it demonstrates how we can find inspiration outside of the product design silo. Biomimicry examines biology through multiple lenses (Benyus, 1997). The most obvious lens focuses on individual organisms. We got Velcro because a scientist Georg de Mestral, who observed the way that burrs cling to animal fur, was able to mimic the process to develop the hook-and-loop fasteners.

To me, this is where most game-inspired product design is right now. We are using games, or *a la carte* game mechanics, to create simple solutions. The final result is obviously game-like, just like hook-and-loop fasteners obviously resemble burrs. In many cases, the final result is actually a game.

How do we get people to exercise more? We immerse them in a mobile role-playing game, like Zombies, Run. Or we give them online achievement badges, like Nike+. How do we get people to recycle glass bottles instead of throwing them away? We build The Bottle Bank Arcade Machine, an arcade game that combines Whack-a-mole and bottle collection (Kim, 2015). These are fun, effective solutions to real problems. But individual mechanics are not the only thing that gaming has to offer. Not every result needs to look like a game, and not every problem can be solved by applying a simple game mechanic.

This is where biomimicry can help. It does not just look at individual organisms, it also looks at the big picture and the underlying principles of biology. What can the basic principles of biology tell us about product design? How do whole ecosystems deal with specific problems, like finding resources or processing waste? Biomimicry finds the answers to these questions, then it turns them into product designs and business strategies (Benyus, 1997).

The final products may not be obviously biological. Interface Modular Carpet, a flooring system inspired by the forest floor, does not actually appear to be covered in leaves and underbrush. But, like the forest floor, it does not matter if one carpet tile, or one leaf, does not exactly match everything around it. It is still a coherent whole (Interface, 2015). This means that Interface does not have to worry that every dye lot looks precisely like the last one, and customers can replace individual carpet tiles instead of recarpeting their entire floor.

Game-inspired design is struggling with this. Most, if not all, of our products still look and feel like games, but researchers, like Gee, Hayes, Salen and Zimmerman, are exploring the big picture and the underlying principles of gaming. As we learn to apply their insights, our designs will become more diverse, less obviously game-like, and more flexible.

In the discussion section of this thesis, I will describe what a ludomimetic learning design might look like. But first, another a game/product hybrid: we are going to use design research techniques to explore game learning.

Chapter 3

RESEARCH DESIGN

Overview

The primary research for this thesis was conducted in two phases. In Phase 1: An Auto-Ethnography of a Puzzle Game, I played through a game and compared it to what I learned while writing the review of literature. Then I used my reading of the game to design and implement a study. In Phase 2: Participant Observations and Interviews during a Game Session, I invited participants to play a game and followed up with a series of questions.

I chose Ico, a puzzle game from Team Ico and Sony Computer Entertainment. In this game, players assume the role of a 10 year-old boy, also named Ico, as he explores a mostly empty, and possibly haunted, castle.

The Phase 1 play-through was a pilot study. I used auto-ethnographic and material-culture study tools to develop an understanding of the game and help me plan Phase 2. I wanted to know what the players would encounter, the challenges they would face, and how their experience would relate to the rest of the game.

Material-culture studies provided my focus: the relationship between the player and the game. How does the player interact with the game? How does the game communicate with the player? How do they both contribute to a successful experience?

During the play-through I was both the subject and the ethnographer. As the subject, I played the game. As the ethnographer, I observed and analyzed the experience.

I went through the game with a controller and a notebook. First, I would play a few minutes, then I would write about the experience, paying special attention to the learning principles built into the game, the actions required to solve puzzles, and the way that one lead to the other.

The study itself employed a qualitative approach and a modified A(x4) strategy, which distills the user experience into four alliterative components: actors, actions, artifacts and atmosphere. The tools I used were observation sessions and semi-structured interviews and the result is a product analysis exploring how games develop product literacy.

Phase 1: An Auto-Ethnography of a Puzzle Game

I went through the game from start to finish, paying special attention to its affordances and learning principles. What actions were necessary to win the game? What skills did they require? How did the game teach those skills?

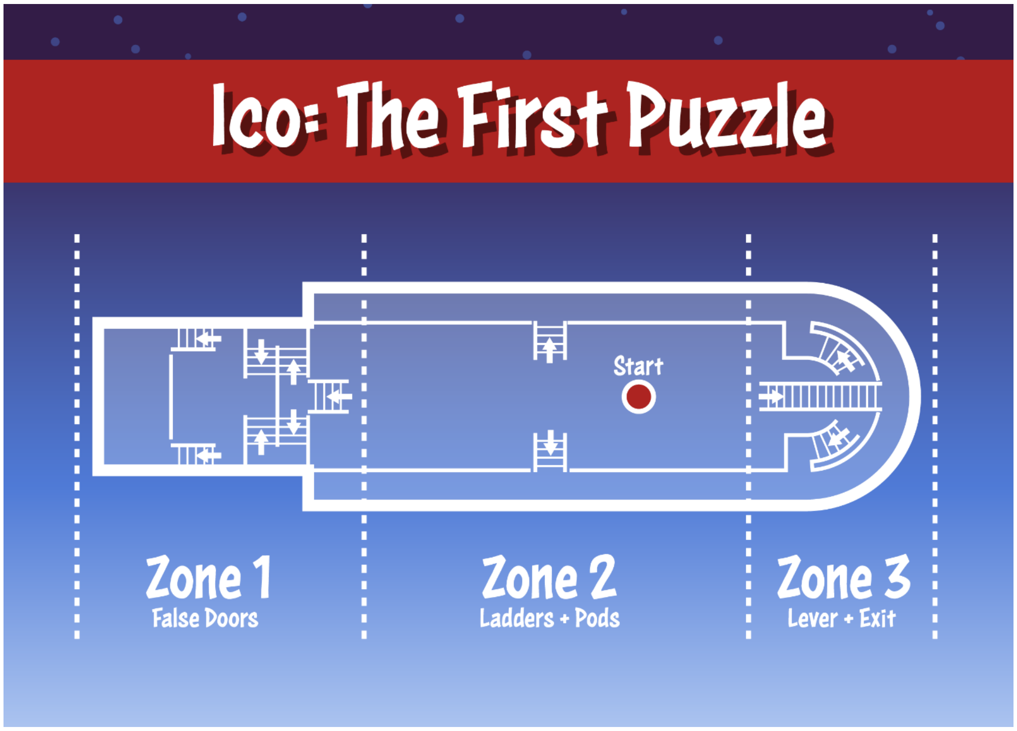
Since the goal of my study was to examine the new-player experience, I focused on the first puzzle. I drew a map. I took an inventory of everything in the room. I wrote out all of the steps necessary to solve the puzzle. I also put Ico through his paces. What could he do in this room? How could he interact with the artifacts? As he solved the puzzle, what actions did he need to perform? How did I learn to perform them?

The first puzzle became my lens for viewing the rest of the game. How did it prepare me for the challenges ahead? Were the skills I learned in the first puzzle useful later? At the end of the play-through I knew what a successful user experience looked like. I knew how the game developed player literacy and what that literacy meant throughout the game.

Ico: The First Puzzle

Before the first puzzle begins, players watch a cut-scene (a short, non-interactive movie). Ico is imprisoned in a coffin-like cell. He escapes with the help of an earthquake. But he hits his head, knocks himself out, and has a vision of a caged figure in a nearby tower. When he wakes up, the cut-scene ends and the player takes control. The puzzle itself is set in a long, stone crypt with several ladders, staircases and ledges. Ico starts on the lowest level, at the red dot in the diagram below.

Figure 6: The First Puzzle



The solution is a simple series of actions. Find a lever hidden in Zone 3. Pull the lever to open a door. Walk through the door.

Zone 1 is a dead end. It has several false doors and staircases that lead nowhere. There are ledges that are just out of reach and a large balcony that players can see but not access. Players can learn valuable skills here, like object identification and jumping, but there are no items that will help them solve this puzzle.

Figure 7: Zone 1

Zone 2 is a gallery lined with ledges and coffin-like pods. One pod, Ico's original cell, has fallen out of its niche and broken open. Players can climb on this pod and, if they run into it just right, move it slightly. Ladders allow players to climb from one ledge to another. Like Zone 1, this area does not contain parts of the solution. But the top ledge can be used as a roundabout route to the lever in Zone 3.

Figure 8: Zone 2

Zone 3 is where the solution is hidden. Three staircases lead to a balcony. There is a lever in the middle of this balcony, and pulling it will open a door directly below it on the bottom level. Walking through the door solves the puzzle and takes players to the next room.

Although it is simple, this puzzle does require several skills:

- Navigate—Players must find their way around the room.
- Recognize objects—Players must identify useful objects, like the lever, and useless objects, like false doors.
- Use objects—Once they find the lever, players must discover how to interact with it.
- Climb a ladder—If players reach the balcony via the ledges and ladders in Zone 2, then they will need to climb a ladder.

Figure 9: Zone 3

The puzzle also introduces several skills that are useful later in the game. None of these skills are useful in this puzzle, but players cannot complete the game without them.

- Climb a ledge—Many ledges and railings in this room are climbable.
- Catch a ledge—If Ico steps carefully off a ledge, he can catch it with his hands before he falls. He can also move hand-over-hand along it.
- Shout—For most of the game, Ico travels with a companion. When they are separated, he can call to her and she will run to his location.
- Push an object—Ico's pod can be pushed very small distances.
- Use Ico's weight—If players jump onto Ico's pod, it will wobble.

Learning Events

To solve the puzzle, new players must perform four tasks. Find the lever. Use the lever to open the door. Find the door. Walk through the door. To perform these tasks, players must learn three or four basic skills, depending on which path they take to the lever: navigation, object recognition, using an object and climbing a ladder.

This creates several easy-to-observe learning events. When a player takes one of these steps or uses one of these skills for the first time, we can conclude that they may have learned something. We can also conclude that a player may have learned something when they become more effective with a specific skill.

I learned that Ico could climb when he bumped against a chest-high ledge. Instead of walking on, he reached out, grabbed the ledge with both hands and climbed up. That was a learning event.

Then I became a better climber by testing Ico's abilities. I tried approaching the ledge from different angles. I tried climbing taller ledges. I tried climbing ledge-like objects, such as railings, ladders and pods. I tried jumping at high ledges, and jumping off them to see if Ico would be injured. Each experiment was its own learning event and each one made me a better climber.

Phase 2: Participant Observations and Interviews During a Game Session

In Phase 2, I conducted research with a several participants who explored learning events and the associated user experience. Participants watched the game's opening cut-scenes and solved the first puzzle while I observed and tracked learning events. Then I interviewed them about the experience.

I recorded a learning event when one of the following things occurred:

- A player used one of the four essential skills (or any skill that may be useful later in the game) for the first time
- A player became noticeably more effective with a skill
- A player focused on the lever or the door
- A player successfully used the lever or the door
- A player rejected a false door, an unreachable ledge or another unusable object
- A player rejected Zone 1 or Zone 2
- A player told me they learned something

I also watched for new learning events that were not discovered during my play-through. When they appeared, I will recorded them too. During the interview, I asked players about the learning events from their play sessions. "Why did you do that?" was my original question, but I also used variations like, "What were you expecting?" or, "What did you hope would happen?" Partly I was looking for the perfect question. But I also wanted to add some variety so the interview felt more like a conversation and less like an interrogation. Depending on their answer, I followed up with questions about their strategies and the results of their actions: "What did you learn?" or, "How did that go?" or, "What happened next?" If I was not sure about what I saw, I might also ask for details.

My goal was to learn five things about every event:

- What did the player do?
- What were the results?
- What did they learn?
- How did they learn?
- How did they feel about it?

To shape my data collection, I employed a flexible, qualitative approach and an A(x4) strategy. A(x4) was proposed in the early 2000s by Paul Rothstein as a way to turn user research into fulfilling and impactful products (L. Anderson & Rothstein, 2004). It borrows techniques from consumer research, ethnography, design and story-telling to examine everyday behavior and build user scenarios. Then those scenarios are used to guide new product development.

Why did I choose this strategy? Because it is built specifically for design research. It takes the user experience, a complex situation with a lot of moving parts, and breaks it into simple, intuitive components. Who are our users? What are they doing? What objects are they using? What is going on around them? These are the four "As" of A(x4): actors, actions, artifacts and atmosphere.

Unfortunately, Rothstein passed away in 2005, before the A(x4) strategy could be fully fleshed-out. Documentation is hard to find, and many of the details are fuzzy. The framework is there. There is just a lot of room for interpretation. I did make some changes to this framework. The actor never changes in this study. It is always a partnership between Ico and the player. The player makes the decisions, and does the learning. Ico drives the story, interacts with the world and provides a fixed set of abilities. So I did not look for new actors while I was observing the play sessions or conducting interviews.

I also expanded the definition of atmosphere. In this study, atmosphere still refers to the emotional ambiance of the real-life situation. How do players feel while they are exploring? Do they appear frustrated, or anxious or relaxed? But atmosphere also refers to the designed atmosphere within the game. What is the camera doing? How does the lighting affect learning? How do cut-scenes change the experience?

Participants

Ideal participants were experienced gamers who played at least 7 hours per week. They were familiar with the Playstation 2, but had never played the game used in the study. This way they would be new to the game, but they wouldn’t struggle with the technology.

I recruited participants by placing posters around ASU's Tempe campus. They invited people to a "study of games, learning and product design" and directed them to an online screening survey.

Twenty-nine people responded to the survey. It collected demographic information and outlined the time commitment (2 short online surveys and a 30-minute gameplay/interview session). It also asked them how often they played games, what devices they used, and how experienced they were with the following games:

- The Ball
- Ico
- Shadow of the Colossus
- Portal
- Portal 2
- Lara Croft and the Guardian of Light

Ico was the least-played game on the list, giving me the largest possible pool of new players. Of the twenty-nine respondents, twenty-two had never played Ico. After scheduling appointments and screening out people who saw the game and realized that they had played it before, there were sixteen participants left.

All sixteen were undergraduates between 19 and 22 years old. Eleven were men, five were women. All of them played games at least seven hours per week and had some experience with the Playstation 2.

Chapter 4

FINDINGS

Introduction

During Phase 1: An Auto-ethnography of a Puzzle Game, I learned how to solve Ico's first puzzle. I also watched the cut-scenes, explored the room, cataloged all of the usable objects, and connected them to the solution.

During Phase 2: Participant Observations and Interviews during a Game Session, I watched the participants and took notes. Then I asked them about the experience. The distinction between observed gameplay and interview started to blur in later sessions. Rather than waiting for players to solve the puzzle, I asked them questions while they were playing. My research plan was iterative. After each play session, I reviewed my notes and looked for patterns. If more than one player did the same thing, or if they did similar things that could be categorized together, I put them in a list of patterns.

Auto-ethnography

Table 1: First Cut-Scene

Events	Lessons Learned
Ico is taken to the castle. Ico's party navigates the castle. Ico is locked up. Ico escapes. Ico has a vision.	This is the main character. This is the setting. This is the situation. This is the goal.

Figure 10: Ico Cut-scene 1 (Partial view of the castle)

Figure 11: Ico Cut-scene 1 (Navigating the castle)

Figure 12: Ico Cut-scene 1 (Ico is imprisoned)

Figure 13: Ico Cut-scene 1 (Ico escapes)

Table 2: Zone 1

Artifacts	Actions/Affordances	Lessons Learned
5 accessible staircases 2 inaccessible staircases 4 false doors 3 closed windows 1 lower balcony 1 inaccessible upper balcony Path on bottom level floor Circle on lower balcony floor	Climb stairs Try to open doors & windows Jump at inaccessible stairs Jump at low ledges Climb up low ledges Jump off low ledges	No exits or solutions Path leads to Zone 2

Table 3: Zone 2

Artifacts	Actions/Affordances	Lessons Learned
37 intact pods Ico’s broken pod 1 lower ledge on each wall 1 upper ledge on each wall 2 staircases to lower ledges 2 ladders to upper ledges Path on bottom level floor	Run Climb stairs and ladders Try to open pods Try to climb pods Jump at inaccessible stairs Jump at low ledges Climb up low ledges Jump off low ledges	Upper ledge leads to Zone 3 Path leads to Zone 1 & Zone 3

Table 4: Zone 3

Artifacts	Actions/Affordances	Lessons Learned
16 intact pods 2 staircases on walls 1 staircase in center Ledge Lever Exit door	Run Climb stairs Try to open pods Try to climb pods Jump at inaccessible stairs Jump at low ledges Climb up low ledges Jump off low ledges Use lever Walk through door	All stairs lead to ledge Ledge leads to lever Lever opens door Walking through door solves puzzle Central path leads to central stair

Table 5: Second Cut-scene

Events	Lessons Learned
Ico pulls the lever Camera cuts to door Door opens Camera pans back to Ico End	Player correctly used lever. The door is open. The door is directly below Ico.

Play Sessions

Table 6: Player 1 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Moved to Zone 1	Saw stairs, doors and torches. “Torches lead to [important] things.”
Explored Zone 1	Ran directly to west end of room. Wanted to “get to the end”. Inspected brick circle on floor. Tested stairs and false doors.
Rejected Zone 1	Actions were not successful. Was not sure if they were “doing the right things.”
Learned to climb	Planned to come back and explore more.
Climbed to top level	Moved directly to ladder in Zone 2. “It’s there for a reason.”
Entered Zone 3	
Explored Zone 3	Ran along ledge from Zone 2 to Zone 3. Only available path at that level. Found lever after running past it once.
Experimented with lever	Stated it was hard to see without a better shadow. Jumped first. Then tried “use” button. Had to reposition twice.
Used lever	
Watched cut-scene	Door opened.
Exited puzzle	
What is the goal?	Escape
When did they ID goal?	First cut-scene.
Other comments	Lots of jumping while running. “I always do that.” Sometimes helps spot things. Had trouble responding to camera movements. Could not run straight ahead.

Table 7: Player 2 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Tested the controller	
	Wanted to know what buttons do.
Explored Zone 2	Had limited previous experience with PlayStation.
Moved to Zone 3	Rant to cardinal points. Then looked around by moving the camera.
Explored Zone 3	Wanted to start at one end of the room
Experimented with	Found lever
Lever	Many jumps.
	Many small repositionings.
	Ran away and came back at least 4 times. Partial rejections
Used Lever	Some frustration with “footprint” of lever
Watched cut-scene	Door opened.
Exited Puzzle	
What is the goal?	
When did they ID goal?	Moved to next room
Other comments	“That’s always the goal”
	Camera movements made it difficult to run in a straight line.

Table 8: Player 3 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Moved to Zone 1	
Explored Zone 1	“Looked interesting.” Inaccessible balcony looked like something from cut-
Rejected Zone 1	scene.
	Tired all stairs. Tested doors. Looked at stairs.
Moved through Zone 2	Partial rejection.
Moved to Zone 3	The solution might be here, but might need to do something elsewhere first.
Learned to Climb	Solution is going to be at the ends of the room, not in the middle.
Explored Zone 3	More light here. Light = important things.
	Bumped into railing on stairway.
	Very short exploration.
Tested lever	Found lever at top of ramp.
Used lever	Jumped first. Then tried “use” button.
Watched cut-scene	Door opened.
Exited puzzle	
What is the goal?	Escape
When did they ID goal?	First cut-scene
Other comments	Camera movement made it difficult to run in a straight line.
	Led to discovery of climbing.

Table 9: Player 4 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Moved to Zone 1	
Explored Zone 1	“Lots of stuff” (Stairs and doors)
	Test each door.
Learned to climb	How did you know you were pressing the right button? Other games use it
Improved climbing	too.
	Accident: Bumped into a climbable wall
	Jumped at out-of-reach ledge. Unsuccessful attempt.
	Assumed jumping and climbing would work elsewhere. Did not test it.
Rejected Zone 1	Why did you assume that? Ico reached up with his hands when he jumped
Explored Zone 2	
	Investigated broken pod because it was different than the others.
Moved to Zone 3	Climbed ladder ran along top ledge
	Top ledge led to Zone 3
Tested lever	Found lever. Balcony/ledge led to it.
Used lever	One jump
Watched cut-scene	Door opened.
Exit puzzle	
What is the goal?	Escape
When did they ID goal?	First cut-scene.
Other comments	

Table 10: Player 5 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	Identified goal: get out of room
Explored Zone 2	Started with pod from cut-scene. Then climbed to top level to look around.
Moved to Zone 1	Saw balcony in Zone 1. Thought it looked like something from cut-scene.
Explored Zone 1	Wanted to make the floor “rise up” to balcony level (like cut-scene). Staircases end in an unusual spot. Too high to reach or climb. Thought floor would rise to meet them. Tested each door and ledge.
Exited Zone 1	Looking for a way to lift floor in Zone 1 (lever, button, etc).
Run through Zone 2	“Didn’t see anything” (levers, buttons, etc).
Enter Zone 3	Bright ambient light looked promising
Explored Zone 3	Found lever. “Everything leads to it.”
Experiment with lever	Tried jumping first. Thought lever height was good for jumping. “Maybe I’m not in the right spot.” Tried inching around and jumping.
Used Lever	Tried other buttons on the controller. Found the interact button.
Watched cut-scene	Door opened.
Exit Puzzle	
What is the goal?	Escape
When did they ID goal?	First cut-scene.
Other comments	Had trouble running in straight line.

Table 11: Player 6 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Tested the controller	Accidentally bumped shout button. Then wanted to know what other buttons do.
Learned to climb	Climbed ledge.
Improved climbing	Climbed ladder to top level.
Explored Zone 2	Jumped off of ledge. Tested pod. Ran back and forth on ledges.
Moved to Zone 3	Followed top ledge
Tested Lever	Jumped then tried “use” button.
Used Lever	
Watched cut-scene	Door opened.
Exited puzzle	
What is the goal?	Find next room
When did they ID goal?	Previous experience with puzzle games
Other comments	Had trouble running in straight line. Fell off ledges in Zone 2.

Table 12: Player 7 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Moved to Zone 3	
Explored Zone 3	“That’s where we came in” during cut-scene.
Tested Lever	Missed lever once. Found on second pass.
Pulled lever	Jumped, then used correct button.
Watched cut-scene	
Learned to climb	Door opened.
Exited puzzle	Bumped into railing on the way to the door.
What is the goal?	Escape
When did they ID goal?	First cut-scene.
Other comments	Watched a play-through video while taking the initial survey. Didn’t remember exactly what to do, but it “Helped a lot.”

Table 13: Player 8 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Moved to Zone 1	Saw balcony and stairs that “don’t line up”.
Explored Zone 1	Focused on unreachable balcony. Returned to it at least 4 times.
	Tested false doors
	Examined circle on floor.
Learned to climb	Bumped into a climbable wall while exploring stairs.
Improved Climbing	Tested jumping and climbing on stairs.
	Then tried to jump and climb to balcony.
Rejected Zone 1	Left to find a way to reconfigure balcony (raise floor, move stairs, etc.)
	Saw floor move in cut-scene
Moved to Zone 2	
Explored Zone 2	Run and scan walls on north side of room. Systematic scan.
Rejected Zone 2	
Moved to Zone 3	
Explored Zone 3	Systematic scan
Tested Lever	Jump then use
Used lever	
Watched cut-scene	Door opened.
Ran to Zone 1	Wanted to see if pulling lever had changed Zone 1
Returned to Zone 3	Was not sure if Ico could go back after leaving room
Exited puzzle	
What is the goal?	Escape
When did they ID goal?	First cut-scene.
Other comments	

Table 14: Player 9 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Tested the controller	Always “mess[es] with the controller” during cut-scenes and loading screens.
Looked around	Stood still and moved camera. Then ran in circles.
Moved to Zone 3	
Explored Zone 3	Moved directly to lever. “It was right there.”
Tested lever	Used correct button first. Was not standing in right place. Tried jumping. Repositioned, tried correct button again.
Used lever	
Watched cut-scene	Door opened.
Exited puzzle	
What is the goal?	Move to next room
When did they ID goal?	Previous experience with puzzle RPG games
Other comments	Lots of jumping while running, searching and standing. Hands never stopped moving on controller. Always flicking joysticks.

Table 15: Player 10 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Tested the controller	Wanted to know what buttons do.
Moved to Zone 1	Deliberate path. No intentional detours. Stopped when dead end was visible.
Moved to Zone 2	Ran through without stopping
Moved to Zone 3	Slowed down on arrival.
Explored Zone 3	Point to point search. Torch first. Then lever. Then second torch. Then lever again.
Tested Lever	Jump then use
Used Lever	
Watched cut-scene	Door opened.
Exited puzzle	
What is the goal?	Escape
When did they ID goal?	First cut-scene.
Other comments	

Table 16: Player 11 Observations

Events and Questions	Experiences, Notes and Responses
Explored Zone 2	Stairs were "right there." Stayed to explore ladders and balcony.
Learned to Climb	Ladder to top level
Moved to Zone 3	Followed top ledge to Zone 3
Explored Zone 3	
Tested Lever	Jump then use
Used Lever	
Watched cut-scene	Door opened.
Exited Puzzle	
What is the goal?	Move to next room
When did they ID goal?	Previous experience with puzzle games
Other comments	

Table 17: Player 12 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Moved to Zone 1	Saw many stairs and doors. Thought one would be the way out.
Explored Zone 1	Focused on circle in the floor of middle balcony. "How do I open it?" Then focused on unreachable stairs. Fixated on this end of the map.
Moved to Zone 2	Not a rejection of Zone 1. Tried to push pod into Zone 1. Wanted to use pod as a stepping stone to unreachable stairs in Zone 3.
Moved to Zone 3	Rejected Zone 2. Did not reject Zone 1. Still looking for a way to reach the balcony in Zone 1.
Explored Zone 3	
Tested lever	Jumped then used. Much repositioning.
Used lever	
Watched cut-scene	Door opened.
Exited puzzle	
What is the goal?	Find the next room.
When did they ID goal?	Cut-scene and previous experience
Other comments	"Objects you can pick up and use are a big thing." Thought Ico's pod was one.

Table 18: Player 13 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Moved to Zone 1	Light and complexity made it look interesting.
Explored Zone 1	Tested false doors and unreachable stairs. Examined floor markings.
Rejected Zone 1	
Moved to Zone 2	
Explored Zone 2	Tested pod
Moved to Zone 3	Focused on stairs as soon as they came in view
Tested lever	Jumped then pulled. Some repositioning.
Used lever	
Watched cut-scene	Door opened
Exited puzzle	
What is the goal?	Escape/ Move to next room
When did they ID goal?	First cut-scene.
Other comments	Runs in circles while thinking.

Table 19: Player 14 Observations

Events and Questions	Experiences, Notes and Responses
Moved to Zone 3	Saw stairs and balcony from the cut-scene.
Explore Zone 3	Found lever quickly. At top of stairs.
Tested lever	Jumped and tried “use” button. Repositioned 2-3 times.
Left Zone 3	Thought the lever might need to be activated elsewhere in the puzzle.
Explored Zone 2	Looking for something to unlock lever.
Explored Zone 1	Tested stairs, false doors and unreachable balcony.
Returned to Zone 3	
Tested lever	Jumped and tried “use” button. Repositioned several times.
Used lever	
Watched cut-scene	Door opened.
Returned to Zone 1	
Explored Zone 1	Looking for “side-puzzles”
Returned to Zone 3	
What is the goal?	Escape
When did they ID goal?	First cut-scene.
Other comments	Frequent jumps while running Zone 1 had so many artifacts (stairs, doors, shapes on floor). Torches too. Surprised it was not a side-puzzle.

Table 20: Player 15 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Moved to Zone 1	"[Ico] was already facing that way."
Explored Zone 1	Zone is "very maze-like". Complexity indicates that something important is here.
Reject Zone 1	
Moved to Zone 2	
Explored Zone 2	Focused on path on the floor. Stopped to examine Ico's pod
Moved to Zone 3	Followed path on floor
Explored Zone 3	
Used Lever	Jumped then pulled
Pulled Lever	
Watched cut-scene	Door opened
Exited puzzle	
What is the goal?	Escape.
When did they ID goal?	Cut-scene
Other comments	Had trouble running in straight line. Fell off stairs in Zone 1.

Table 21: Player 16 Observations

Events and Questions	Experiences, Notes and Responses
Watched cut-scene	
Explored Zone 2	Stairs were close.
Moved to Zone 3	Length of stairs looked important. They were "going somewhere."
Explored Zone 3	
Tested lever	Jump then pull
Used Lever	
Watched cut-scene	Door opened
Explored Zone 1 and 2	Quick search Looking for "things to pick up" and side-puzzles
Exited puzzle	
What is the goal?	Escape
When did they ID goal?	First cut-scene.
Other comments	Jumper Crooked runner

List of Patterns

Table 22: List of Patterns

Pattern	Examples
Accidentally performing a new action	Bumping into a climbable object and climbing it Falling off a ledge and catching it Accidentally pressing a button on the controller and being surprised by the results
Analyzing the game as a system	Deciding that the lever is important because it has more detail than other nearby objects. Rejecting false doors based on the low-quality of their graphics
Fidgeting while thinking, exploring, travelling or waiting	Flicking the controller's joysticks while watching a cut-scene Jumping while running Jumping while standing still Running along a repeatable route Running in a circle
Finding the solution by fixating on the wrong thing	Searching for a lever or button to rearrange Zone 1
Following a well-defined path to the solution	Finding the lever at the top of the stairs in Zone 3 Following the path on the floor Running along the top level of Zones 2 & 3
Testing an action by trying it in several different locations (or with several different objects)	Jumping at several different ledges to see which ones are climbable Pressing the interact button at every false door
Testing an object (or location) by trying several different actions (or buttons)	Climbing, jumping at or running at Ico's pod Jumping at the lever, then trying other buttons Standing next to a door and pushing each button on the controller
Using information from the cut-scenes	Concluding that the floor can be raised and lowered Exploring Zone 1 because it looks like something from the initial cut-scene Exploring Zone 3 because they saw it in the cut-scene Finding the exit after pulling the lever Identifying the goal
Using knowledge from other games	Assuming that Ico uses the same control layout as other 3D Playstation games. Following torches because other games use them to mark interesting objects Identifying the goal based on experience from similar games Searching for side-puzzles

Chapter 5

ANALYSIS AND INSIGHTS: THE GAMIING EXPERIENCE AND THE LEARNING EXPERIENCE

Introduction

In this chapter, I will explain my analysis and insights into the gaming experience itself, and the learning experience that unfolds while playing games. To understand the gaming experience, I used the A(x4) framework, which classifies experience into four categories: actors, activities, artifacts and atmosphere. To understand the learning experience, I created a new framework that examines learning styles (practice-based and study-based) and learning forms (structured and free).

The Gaming Experience Ax(4)

To organize the data and identify patterns within the gaming experience, I created text snapshots of the actions, artifacts and atmospheres from the play sessions and my own play-through. In a standard Ax(4) analysis, I would also make snapshots of the actors, but there was only one actor in each of the play sessions. Therefore there was no need to distill this category further. The A(x4) snapshots were an intermediate step to help me make sense of the data. My final goal was to create a set of broad learning styles and learning forms.

The snapshots started as a list of patterns. Whenever two or more players did the same thing, I made a note of it and asked them about it during their interviews. The pattern also went into my list of learning events, so that I would remember to watch for it in later sessions.

When the sessions ended, I sorted the patterns into Ax(4) categories and used them as the foundation for the analysis below. Then I revised and expanded the analysis by reviewing the notes from individual sessions.

Actions

This section outlines the actions undertaken by the subjects of my study. The actions are indicators of how users interact with products, and can be helpful design tools. The primary actions I observed during the study are:

1. Survey the Environment
2. Make a Beeline
3. Perform a Single Experiment
4. Perform a Multi-Part Experiment
5. Twitch

Survey the Environment

When players explored a zone, they often looked around before they interacted with anything. Along with experiments, this was the most common action.

Some players did this by running around the room. Others stood in one place and moved the camera. A few players had systems too. Once of them scraped the edges of each room, sticking close to the wall and exploring all of the boundaries. Another paid special attention to the corners and shadows. A third climbed as high as he could, then looked down on the puzzle from above.

Once a player spotted something interesting, like a decoration or an interactable object, surveys usually turned into beelines or experiments.

Make a Beeline

When a player spotted an interesting object, like the lever or a false door, they frequently abandoned their surveying and ran straight to it. In most cases, this was followed by an experiment.

Perform a Single Experiment

There were two types. In a 1-part experiment, players would move to a spot and attempt a single action, like jumping or pushing the interact button. If it did not work, they'd reposition Ico and try the action again. After a few unsuccessful tries, they'd move on.

If a zone had several spots that looked climbable or interactable, players would move from station to station, trying the same action at every spot.

Perform a Multi-Part Experiment

If a player was convinced that they had discovered the key to a puzzle, but they did not know how to use it, they performed a multi-part experiment. They'd get close to the object, then they'd try several actions, one after another.

The lever was a frequent spot for experiments. It is a big, t-shaped toggle switch that sticks out from the wall. It looks like Ico needs to jump up and grab the crossbar, like a trapeze. So players would run to the switch and jump at it. No matter how many times they jumped, or where they positioned Ico before the jumped, he never grabbed the switch. The switch simply was not jumpable.

But when players scooted a little closer and pressed the interact button, Ico reached up, grabbed the shaft of the switch and used it to open the door. Most players figured this out when they got tired of jumping and started testing all the buttons on their controllers. After a few buttons, they discovered the solution and identified which button to use in the future.

Other common sites for multipart experiments were the false doors in Zone 1, the unreachable balcony in Zone 1 and Ico's prison pod in Zone 2. When I write that someone tested something in the "Findings" chapter that usually means that they were performing a multi-part experiment.

Twitch

Some players would perform a single action, over and over. The specific action varied from player to player. I saw players jumping up and down, running in circles, climbing a staircase then jumping off the landing, zooming the camera in and out, and flicking one (or both) of the controller's joysticks.

When I asked them about it, most players said it was just a habit. They did similar things in every game they played. Some players could not explain why they did it. Others claimed it helped them spot things in the game.

Artifacts

This section outlines the key objects that the players interacted with during the study. They are:

1. Interactable Objects
2. Decorations

Interactable Objects

Ico can interact with some of the objects in a castle. He can flip switches, climb ladders, pick up torches, and so on. In the first puzzle, for example, he has to pull a lever

Many interactable objects stand out from the environment. Like the lever in Zone 3, they may be the only object of that type in the room. They may be a slightly different color or texture. They may also catch the light differently or have more detailed 3D models.

Decorations

Most of the objects in the castle are decorative. False doors, inaccessible staircases, wall sconces and inlaid floors make the castle more interesting, but they also provide misleading information.

Until they were sure they could not use a decoration, players would treat it like an interactable object. They ran straight to it. They performed experiments on it. If a player had difficulty with a puzzle, they might come back to a decoration, like the inaccessible balcony in Zone 3, several times.

Decorations were not always misleading. Some players found the lever in Zone 3 because they followed the torches. The zone had several torches on the wall. They made it much brighter than the rest of the room and led players straight to the exit lever.

Atmosphere

Sometimes, the game’s environment had a direct impact on the players. The “Atmosphere” section outlines those impacts. They include:

1. The Third-Person Experience
2. The Cut-Scene Experience
3. The Point-of-View Experience

The Third-Person Experience

Ico is a "third-person" game. Instead of seeing through the main character's eyes, players view the action from a distance. So they can see Ico himself, as well as what is going on around him.

In many third-person games, the camera stays at a fixed point relative to the character. 3D games might put the camera above and slightly behind the main character. 2D games might put them directly above or directly to one side. But Ico uses a flexible viewpoint that changes as the main character moves around.

In the first puzzle, for example, the camera starts beside and slightly above Ico. As he runs to either end of the gallery, it swings to follow him. So the perspective changes while Ico is moving.

The moving camera makes can make it difficult to control Ico. One moment he's running towards the eastern side of the room. Then the view rotates 90 degrees and the same command causes him to move towards the southern wall. If the player wants to keep moving east, they have to use a different command. Fortunately the camera shifts slowly, so players can make course corrections. But it means that Ico rarely runs in a straight line. And he has a lot of accidents.

Like many of the game's quirks, this can be useful. In our sessions, Ico's slightly drunken weaving led to important discoveries. In some cases, he literally bumped into important objects. In others, he accidentally tried to climb ledges and railings, revealing climbable objects and teaching players how to climb.

Players can also take control of the camera. They can pan in any direction and zoom in or out. When a player releases the camera, it snaps back to its automatic position.

The Cut-Scene Experience

Ico's cut-scenes follow a pattern. First Ico stops responding to the player and the screen's aspect ratio changes. Black bars cover the top and bottom of the screen, so the remaining image looks like a widescreen movie. Then the cut-scene plays. When it finishes, the camera returns to Ico, the aspect ratio returns to normal, and the player regains control.

Cut-scenes are a rich source of information. They introduce the story, warn players about upcoming dangers, reveal where they should go, give them new goals, and show them the results of their actions.

The first puzzle includes 2 cut-scenes. Before the action starts, players watch Ico’s imprisonment. After a player pulls the lever, another cut-scene shows them where to find the exit.

When players did something useful, like pulling the lever in Zone 3, they heard special sound effects, like the rumble of giant gears, and the creak of ancient mechanisms in motion.

The Point-of-View Experience

While in this puzzle with Ico, players never see the world through Ico's eyes and therefore do not adopt his point-of-View, that is a common experience in games. In this type of an experience, players would have collapsed their identities with that of Ico for the duration of the game.

Conclusion: The Gaming Experience

The A(x4) framework has served as a guide when I categorized the kinds of actions, artifacts and atmospheres players encounter in games. These three categories of player encounters have helped me in developing principles for application in product design. These will be covered in the following chapter.

The Learning Experience Framework

This framework organizes the learning experience into a biaxial map, based on how much freedom users have, and whether they rely on practice or study. This framework can also function as a bridge between games and products.

Game design and product design may be similar, but they are still two disciplines that operate in completely different worlds. The learning tools that help players navigate Ico's castle cannot be grafted directly onto a product. They need to be translated first.

To close the gap between product design and game design, I borrowed a tool from biomimicry. Like game design and product design, biology and product design also operate in very different worlds. They require different literacies. They have different goals. They even use different languages (Baumeister, Tocke, Dwyer, Ritter, & Benyus, 2013). A design question, like "How can we make it easier to learn the features of our new smartphone?" is meaningless in biology, where smartphones and their associated features do not exist.

At the start of a biomimicry project, Dayna Baumeister and her colleagues encourage designers to "biologize" their research questions: "…take a human need or function, and rephrase it so that an answer may be found in biology, e.g. ‘How can I make the fabric red?’ becomes ‘How does nature create color?” (Baumeister et al., 2013). A perfectly distilled question should make sense to biologists. It should also generate a large, yet manageable, pool of solutions when biologists search the literature.

Once the biological solutions have been gathered, researched and evaluated, Baumeister, et al., translate them back into the language of design. The final result is a set of abstracted design principles that bridge the divide between biology and other disciplines:

> “A design principle, like a function, lingers in the neutral territory that does not belong exclusively to biology, engineering, business, or any other discipline. Rather, it captures the essence of the biological strategy and translates it in a way that is biologically accurate, but devoid of confusing biological jargon.” (Baumeister et al., 2013)

The learning experience framework I describe in the next section is a similar act of translation. It expresses gaming concepts (the learning principles from my Review of Literature and the data gathered from this study) in the language of product design.

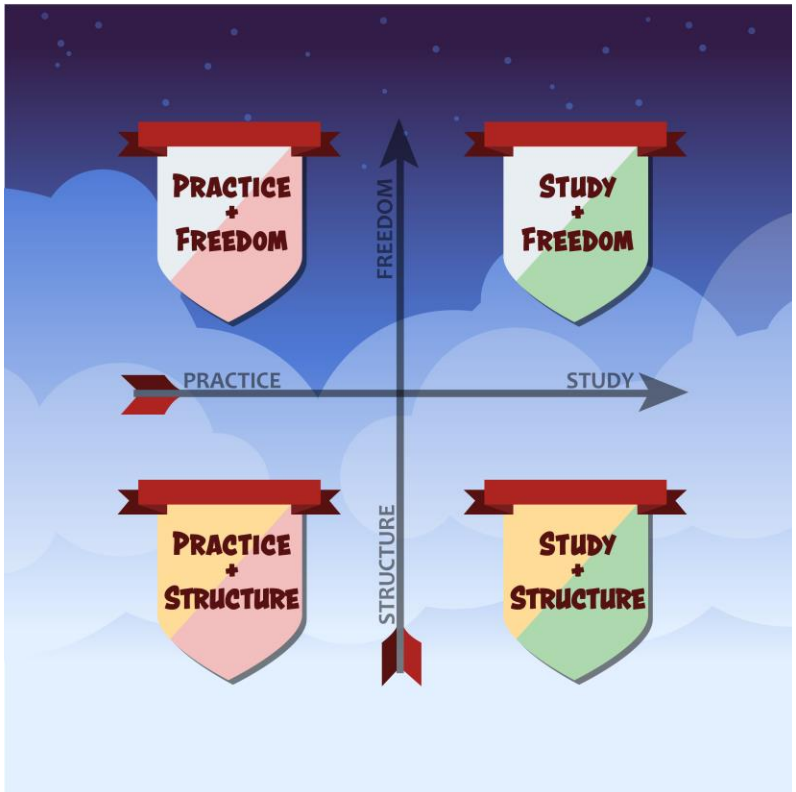
A Biaxial Structure for the Learning Experience

This framework is built around a biaxial map. One axis is practice versus study, and the other is free versus structured.

Practice vs structure is modeled after two of James Gee’s learning principles: “Active, Critical Learning” and “Probing” (Gee, 2007). Practice is completely active learning. Players learn by taking action, evaluating the results and adjusting their approach until they reach their objectives. Passive learning requires no action or testing.

Freedom vs study is modeled after the “Multiple Routes” principle (Gee, 2007). Completely structured learning has one goal and one narrow way to reach it. Completely free learning has an unlimited number of goals and an unlimited number of ways to reach them. In free learning the user chooses the path and the destination.

Figure 14: Practice vs. Study, Freedom vs. Structure



Practice-based vs. Study-based Learning Styles

This axis focuses on what users are doing while they are learning. Are they experimenting? Are they passively receiving information? Is what they are learning relevant to what they are doing right now? Will that information make them better at their current task?

Practice is experimental and experiential. The player takes an action, evaluates the results, and uses what they learn to guide their future actions. They are not just learning information, they are learning how to apply it in the game world. Ico is built around this kind of learning. Players learn about the puzzles, and their own abilities, by using those abilities to solve the puzzles. They learn by taking action. And what they learn affects what they do next.

Study is disconnected from the action. Players receive raw information rather than developing it through experience. A pop-up window may deliver a mission briefing or a computer controlled character may tell them something about the game world. This kind of learning is not linked to what the player is currently doing. It may be immediately relevant, or it may not. It may, or may not, be actionable. In some cases players may never be able to put it into practice.

Free vs. Structured Learning Forms

This axis examines how the form of learning relates to the goals of the game. Who sets goals? How flexible are they? What learning experiences do they encourage? How important are they to the game's progression?

With structured learning, the game sets the goal. Ico's learning is highly structured. Each section is a puzzle with a set solution. Players solve it by performing specific actions in a specific order. When one puzzle is solved, the game unlocks the next one.

Aside from the implied "solve this puzzle to move onto the next one," most of Ico's goals are hidden. Discovering the unique goals of each section is part of the puzzle. When the player finds a locked door in the first puzzle, for example, they learn (or at least suspect) that the goal is "open this door." Here, the learning form is more structured.

Ico does have clear, overt goals too. At one point later in the game, Ico tells another prisoner, "I will get you down <from a hanging cage>." He is not just making a promise to her. He is also giving the player a goal.

The first puzzle's locked door tells us something interesting about structured learning: you do not need to know the goals in order to achieve them. What if the player finds the lever before they find the door? They can still achieve the puzzles' goals. If the player pulls the lever, the door opens, no matter what the player thinks about the goal. Whether or not the player knows the goal, the game still advances.

In the free learning form, the game does not set the goal. The player may choose a goal for themselves. Or there may be no goal at all. Free learning may lead to valuable insights, but it is not essential to the game's current goals.

Ico's early puzzles have limited opportunities for free learning. Jesse Schell would say that the puzzles provide "the feeling of freedom" rather than actual freedom (Schell, 2008). But there are a few objects and locations that can be freely explored. One early example is a row of pots in the game's second puzzle. Ico can pick them up, set them down, smash them or throw them. But no matter what he does with the pots, it will not affect the puzzle.

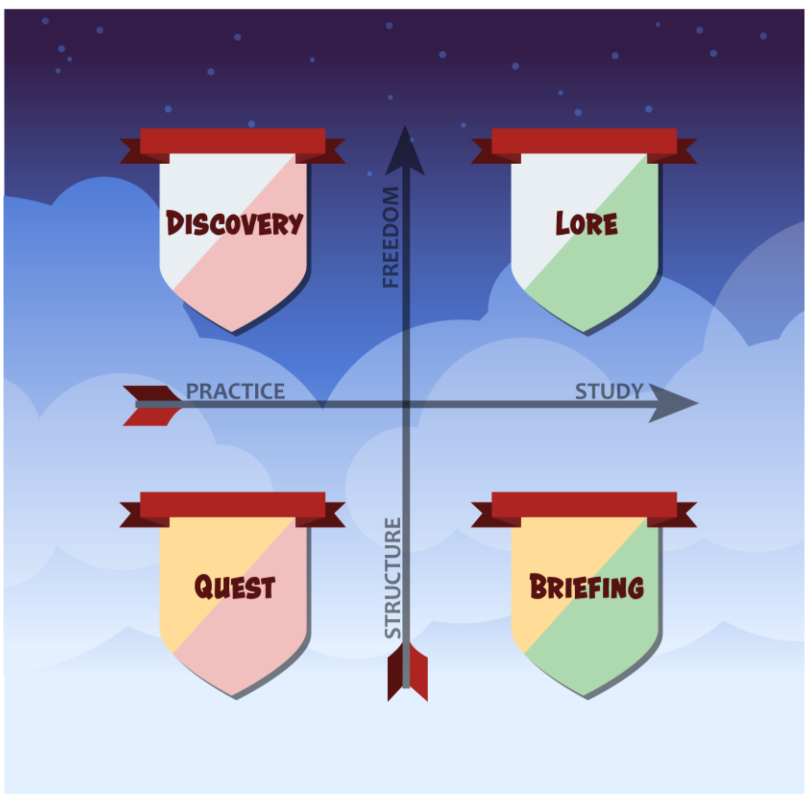
Does this mean the pots are useless? No. By interacting with the pots, players learn how to interact with other objects. Later in the game, when they find a puzzle that can only be solved by setting an item down in the correct location, smashing something, or throwing an object at a target, players who experimented with the pots in puzzle 2 will already know how to do it.

The Learning Experience Framework

I used these axes to create four learning experiences, one for each quadrant on the map. One experience will focus on “structured practice”, another will focus on “free study” and so on.

These experiences have game-like names, and in this section they describe actual game experiences. But they can be used outside of games. They do not even have be game-like. We will explore that further in the next section.

Figure 15: The Experience Framework with Four Experiences



Quest (Practice + Structure)

A quest is an assigned task that advances the game.

In Ico, questing is how you solve puzzles. The game provides a goal: get to the next room, rescue another child, pull, etc. That goal may be explicitly stated or not. Either way, completing it will advance the story and unlock a new portion of the castle.

There may be more than one way to complete your quest. You could climb a ladder, and run along a ledge until you find the switch that opens the exit door. Or you could search until you find the staircase that leads directly to the switch. As long as you flip the switch, how you get there does not matter.

Quests can pop up in any game, regardless of genre. When one of Tyria's greatest heroes tells the Guild Wars 2 character to travel halfway across the continent and slay a dragon, that is obviously a quest. When Flo, the main character of Diner Dash, tells you to seat the first customers of the night, that is a quest too. Any assigned task is a quest. It can be long and arduous, or simple and quick. It can be overt or hidden. As long as the task is necessary to advance the game, it is a quest.

The things you learn during a quest are doubly useful. They help you reach your current goal, but they help you reach future goals too. Well-designed game learning builds on itself. Each quest uses the knowledge you've already acquired. Then it adds an extra layer of challenge and learning (Gee, 2007).

Discovery (Practice + Freedom)

Discovery is unguided exploration.

From the outside, discovery may look like a series of accidents and aimless wanderings. But even though the player is not advancing the game, they are developing their skills. What they learn may become valuable once they resumes questing.

Ico's first puzzle has a lot of room for discovery. There are ledges and railings for climbing and jumping and wide open spaces for running. In our game sessions, many players took advantage of the opportunity.

Before they searched for a way out of the room, they gave Ico a quick test-drive. They ran back and forth. They climbed up a ledge and jumped off. They tested the limits of Ico's abilities by jumping over railings and trying to reach inaccessible ledges. The process rarely took more than a minute, but it taught players what they could do and what they should look for in the future.

Briefings (Study + Structure)

Briefings are passive bits of information that help you reach a goal.

Many of Ico's briefings are delivered through cut-scenes. When Ico pulls the lever, a quick cut scene shows the newly opened door and the path to reach it. His new goal is clear: go through the door.

Ico's briefings are not always explicit. At the end of the first cut scene, most of the players in my study decided that their goal was to escape the castle, but not everyone described it the same way. Their answers ranged from “escape the castle” to “get out of this room” to “move to the next room”. They all agreed that getting out of the room was important, but based on the cut-scene none of them knew how to do it.

Star Wars: The Old Republic, on the other hand, is very explicit. Briefings come with clear calls to action, accompanied by pop-up notifications and visual aids. When a Republic senator tells your character to stop the riots in the Galactic Market sector, she tells you exactly where to go and who to talk to. You receive a map with the location marked clearly upon it. An icon on your screen points the way to the riot. Your mission log keeps a running tally of how many rioters you need to defeat and how many you have already defeated.

Depending on the designers' goals, either approach can work. Ico is a puzzle game. Finding the right path is part of the fun, so the briefing does not tell you where to go. Star Wars is more concerned with the story and the action. So its briefings make getting to the action as easy as possible.

Active learning is great, but it is not the right tool for every situation. Sometimes players want to skip ahead. A well-placed briefing is a way to eliminate the tedium and get right to the good stuff.

When Ico opens the door, the designers could have skipped the cut-scene. They could have forced players to figure out, “What did the lever do?” or “Where do I go now?” But thanks to a timely briefing, players did not have to answer those questions. The game rewarded them for solving the first puzzle by quickly pointing them towards the next one.

Lore (Study + Freedom)

Lore is passively acquired information that does not relate to a game's goal.

Lore does not tell you how to solve a puzzle or defeat a foe, it tells you why. It establishes the game's setting and tells the player how they fit into the game. Lore is what turns a cluster of pixels into a character, and a list of objectives into a story.

Other types of learning are enriched by lore. Ico would still be an entertaining puzzle game if players did not know why he was wandering around the castle. Experiments would still occur. Problems would still be solved. But knowing more about Ico makes those experiments and solutions more meaningful.

Ico delivers most of its lore through dialog and cut-scenes. During the first cut-scene players learn that Ico's captors believe that they are imprisoning Ico for the good of their community. Later in the game, Ico tells another child that the adults of his village tried to sacrifice him because he was born with horns. Every horned child is locked away in the castle. This information helps players understand Ico's situation. It establishes an emotional link with the character. It motivates them to help him, but it does not solve puzzles or make them more skillful.

Unless they are completely abstract, most games have lore. There is a story behind Diner Dash's Flo. She is a former business executive who owns a restaurant. Magic the Gathering puts flavor text on all its cards. Star Wars: The Old Republic wraps the whole game in colorful characters, alien landscapes, and intricate stories.

Conclusion

These four learning experiences are interdependent. Learning experiences may fit into multiple categories at the same time. A game's story may be mostly lore, mixed with a few briefings. A quest might require you to gather several pieces of lore. This is a specialty of Star Wars: The Old Republic. When the game wants you to learn about a new feature, it sends you on an information-gathering quest.

Some learning experiences are natural partners. Missions are often preceded, or advanced, by briefings. And lore can be a reward for completing quests or performing exploration.

As a game advances, learning experiences may shift from one profile to another. Players may discover that a piece of lore is actually a vital briefing. Achievement rewards may transform exploration into questing. Outdated or outgrown skills may fade into lore.

Chapter 6

FROM GAMES TO PRODUCTS

Introduction

I started this project with three goals.

First, I wanted to understand what game learning looks like. What do people do when they are learning a game? How does the game shape their experience?

This was accomplished with primary research. I played through a game and reflected on the experience. I watched subjects play games, I asked them about the experience. Then I distilled the data into four learning experience profiles: discovery, lore, quests and briefings. These profiles are information delivery vehicles. Game designers use them to develop gaming literacy

Second, I wanted to identify areas where game design could improve the design of product user experiences, especially product learning and address the following questions. Where do product learning experiences occur? How do games deal with similar learning situations?

This was explored in the review of literature. Game design and product design use many of the same tools. Game design also has a wealth of learning principles that can be transferred to product design.

Third, I wanted to develop a toolkit for using game design principles to improve product learning. How can I make product learning more engaging and effective? How can it be more game-like, without actually becoming a game?

In the rest of this chapter I will introduce and explain four game-inspired learning principles and a toolkit for designing effective product learning experiences.

Key Principles of Game Learning and Product Learning

These principles are distilled from both my primary and secondary research. The learning principles themselves are adapted from James Gee's *What Video Games Have to Teach Us About Learning and Literacy*. The communication tools were developed during my study.

Principle 1: Start Small

The learning experience should start in a small subset of the product's domain. Designers can introduce the core function of the product and start the user off with a quick and satisfying success. It is important to give the user a simple task that directly relates to the core function of the product. They should receive only the tools they need to complete the task— nothing else. It is essential to reduce the chance of failure as much as possible. Although it is limited, this small world should accurately reflect the larger one. What works in here should also work out there.

Principle 2: Reward Users with New Tools and New Quests

When users complete a quest, they should be given a reward. These rewards should be more than satisfying, they should be useful too. And they should help build the user's literacy. New tools make great rewards. Designers can start by giving the user a tool that relates to what they just learned. Then they can give the user a new quest that combines their current expertise and their new tool. This expands the domain and gives the user bigger challenges, which further develops their skills.

Principle 3: Let Users Choose Their Goals

The first few steps of the learning process are typically very structured. That is unavoidable if designers want to minimize the risk of failure. But a good learning experience should encourage discovery and allow users to choose their own goals.

Once the users have developed a basic literacy, their rewards should include new options, as well as tools and new quests. Offering several quests at once and allowing users to complete them in any order allows for customized experiences and makes learning more relevant for each user.

Designers can use lore to provide context and introduce new connections. Does a user want to keep exploring a newly-learned tool? The product can reward them with examples of how other people have used it. Does the user want to know more about how that tool works? The product can tell them what the tool is intended to do or what is happening inside the product.

Principle 4: Push Users' Limits

Games are engaging because they are challenging. Jesse Schell instructs game designers to maintain a steady stream of challenges that test the user without being too difficult. James Gee encourages them to live just outside the user's "regime of competence", where users must push themselves and develop new skills in order to succeed.

This "pleasant frustration" is a core component of the gaming experience (Gee, 2007). Early failures are OK, as long as gamers can expect to succeed in the future. It may take a paradigm shift for product users and product designers before we are ready to embrace challenge and failure too. But this attitude is highly conducive to learning.

Experience Points: A Product Learning Toolkit Inspired by Game Design

The Experience Points Product Learning Toolkit is the destination of this thesis. It is rooted in the learning principles of gaming, as described in my review of literature, and it employs the four learning experiences from my study—discovery, quests, lore, and briefings—to deliver information and build product literacy.

This toolkit is a user-interface design system for digital skill-based products like smart phones, digital cameras, tablet computers, etc. The learning experience would unfold in a preinstalled, game-like app that would replace a traditional tutorial. Experience Points is the tool for designing these apps. Designers would use it to plot out the learning scenarios. Then the app would be coded by a programmer.

These are the steps for using the toolkit.

1. Evaluate product for suitability
2. List functions
3. Categorize functions
4. Create a list of actions for each function
5. Create a list of rewards
6. Create a list of potential dangers
7. Create a list of strategies to mitigate the dangers
8. Design the game-like learning experience for product

Step 1: Evaluate the Product for Suitability

This toolkit is specifically designed for smart skill-based products and skill-based everyday things. Suitable products should have the following features and capabilities:

- They should have a digital processor that is capable of running a game-like app
- They should have audio-visual means of communicating with users

The processor and memory should be powerful enough to track user behavior and deliver a progressive stream of information. It should also be able to lock and unlock the product's features. Smart phones, with their customizable interfaces, powerful processors and large memories would be ideal. But simpler products, like digital cameras, would work too.

Ideally, the means of communication should be multimodal. Smart phones are a good fit here too. With screens, speakers and haptic feedback, they can reach three of the senses. Plus they can reach out to their users via email, text, push-notifications and social media. Users can communicate with their smart phone whenever, however, and wherever they want to. Again, simpler products would also work, as long as the mode of communication is clear and easy to access.

Step 2: List the Product's Functions

The second step is listing all the product functions that should be incorporated into the learning experience. For example, in case of a tablet computer, this would include turning it on, charging it, using it to open email, drawing on it, and so on. These functions should all be jotted down in the form of a long list.

Step 3: Categorize the Functions

The next step is to put the functions into the following categories:

1. Core functions
2. Essential functions
3. Frequent functions
4. Advanced functions
5. Startup functions

The core function is the most important thing that the product does and it is the first thing you are going to teach the user. If the product is a camera, the core function would be “take pictures.” Some products have multiple functions. For example, messaging software sends messages and receives messages. Both functions are equally important. In this case, designers will need to choose one and call it the core function.

The next step is the identification of the essential functions. Without these, your core function won’t work correctly. For a camera, the essential functions might be “view pictures” and “transfer pictures to another device”.

Put your essential functions in order. You could put them in order of importance. This is a judgement call and it requires some empathy with your users. Which function would they value most, “view pictures” or “transfer pictures to another device”? If there’s a strong preference towards one or the other, then the preferred function is more important.

You could also put the essential functions in order of operation. If you know that your camera users will take pictures first, view them second, and transfer them to another device third, then “view pictures” would be ranked ahead of “transfer pictures to another device”.

Frequent functions aren’t essential, but they are something that users will do regularly. Maybe every day. Maybe several times a day. For a digital camera, this would be things like recharging the battery, replacing the memory card, deleting pictures, changing the flash settings, and (if the camera is equipped for it) sharing pictures with other users. Just like the essential functions, put this list into some kind of useful order.

Startup functions, like receiving the battery, receiving the memory card, uncovering the lens, and turning the camera on, are barriers that must be crossed before users can access the core function. When possible, the startup functions should be performed before the user gets the product in their hands. That lets the user start a few steps closer to the core function.

If a memory card and fully-charged battery are installed before a camera reaches the user, for example, that user doesn’t need to worry about them before they start taking pictures.

Step 4: Create a List Actions for Each Function

This step is like writing instructions. Pick a function. Write down all of the necessary steps. For example: 1. Point the camera at something. 2. Look through the viewfinder. 3. Press the shutter, and so on. These are actions users will need to perform every time they take a picture.

While creating a list of actions, it is critical to look for complex steps with a high risk of failure. Manual camera adjustments can be tricky. Without practice, it's easy to choose the wrong focus or exposure setting. In step 5, these perilous functions will go on your list of dangers.

Step 5: Create a List of Potential Dangers

Identify all the ways that the function can fail. A camera failure might be a bad picture. It could be out of focus, too light or too dark. Something could be in the way, or the camera could be pointed in the wrong direction.

Step 6: Describe the Consequences of Each Danger

What happens if the function fails in this way? The camera can prevent many bad picture problems with timely briefings. Tell the user when a picture they're about to take looks underexposed or out of focus. It can also take risky functions, like manually adjusting the focus, out of the user's hands, by putting everything on automatic.

Step 7: Make a Plan to Prevent Each Danger

This is especially important for the core and essential functions. You want to minimize the chance of failure, so that users can practice the function without worrying about making mistakes.

Step 8: Reduce the Consequences of Each Danger

It is unlikely that the designer will be unable to eliminate failure altogether, so it is important to also ask "How will users recover from failure?" The ideal recovery should be quick and painless. Recovering from a bad digital photo is already quick and painless. It only requires taking another picture. Recovering from other product failures may require more planning.

Step 9: Put the Functions in Order

Put all of your functions in a list, starting with the core functions, then the essential functions, then the everyday functions. Here's what our camera's list would look like:

1. Take pictures
2. View pictures
3. Transfer pictures to another device
4. Share pictures with other users
5. Delete pictures
6. Change the flash setting
7. Charge the battery
8. Replace the memory card

For learning that goes beyond basic literacy, you should also identify your product's remaining advanced functions. You don't want to list every function. That may take forever, especially if your product has a lot of options, is a platform product, or receives regular upgrades. Limit your list to the ones that are the most common, most interesting and most rewarding for your users.

For our camera, the list could look like this:

- Understand the icons and information in the viewfinder
- Navigate the settings menus
- Use macro mode
- Use sports mode
- Use landscape mode
- Use portrait mode
- Record a movie

These functions will be the foundation of your advanced lessons. You don't need to put them in order. When users are ready for them, they're also ready to choose where they want to go next. So you'll present several of them at once instead of one at a time.

Step 10: Create a List of Rewards

Here, a list of rewards can be made that can encourage users to go through the entire learning experience. These rewards can be simple things such as the ability to move on to the next level, or next function. It can also be learning about a new tip or feature of the product. These rewards should be such that they are enticing to the user, and promote the continuation of the learning experience.

Step 11: Design a Game-Like Product Learning Experience for the Product

This is where Experience Points would merge with a standard app development process. Because it is game-like, you can develop the learning experience like a game.

Each function is a learning scenario. The main character is the user. The product is a supporting character who gives the user a quest. For a camera, that quest might be “take 20 pictures.” The user takes the pictures. The camera tracks the user’s progress and rewards them when they reach 20. The reward: a picture viewer, which comes with another quest.

A simple learning scenario might look something like Table 23.

Table 23: Simple Learning Scenario

Step	Description	Example
I	Give an initial briefing that introduces the function and describes the necessary actions.	“Let’s start by learning how to take pictures. First, make sure that you’ve removed the lens cap. Then look through the viewfinder, point the camera at your subject and press the shutter button.”
2	Assign a quest that uses the core function and encourages discovery.	“Look around you. Take pictures of 20 different things.”
3	While the user is working on the quest, use timely briefings to help them avoid danger and recover from mistakes.	“This looks very dark. It might be underexposed. Try using more light.”
4	When the user completes the quest, reward them with a new tool.	“You just took 20 pictures. Good job. Now let’s take a look at them.”

At this stage it is critical to decide how the product will communicate with the user. Does the device have video or audio? Can it communicate with other devices or apps? A digital camera, for instance, has a screen and a viewfinder. We could use both of them to communicate with our user.

It's also important to decide what kind of information to provide. Where will the briefings be used? Definitely at the beginning of the quest. The user needs to know what to do. One could also use briefings during difficult steps, to point out danger. Where will you use lore? In the early steps, lore and discovery add complication without helping users perform their tasks. But in later quests designers can use them to encourage creativity, help users make connections between functions and spot new opportunities.

Next Steps: Where Do We Go From Here?

This thesis document is an early attempt to extrapolate learning from game design and game playing to apply to product design. The following areas of research demonstrate future potential for this research project.

1. The Development of a Digital Toolkit
2. The Creation of a Learning Experience for a Sample Product
3. Further Research into Game Theory for Product Design (In Addition to Learning)

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APPENDIX A

SAMPLE EXPERIENCE POINTS WORKSHEET

Experience Points	Part 1

Getting Ready

In this worksheet, you'll determine whether your product is a good fit for Experience Points. Then you'll list your functions, write instructions, identify dangers and set up rewards for your users.

Step 1: Determine whether your product is compatible with an Experience Points app.
Answer these questions:

- Does my product have a processor that is capable of running a game-like app?
- Can my product communicate through video and/or audio?
- Does my product require an extended, skill-based learning process?

If you answered “yes” to each question, then your product is a good fit for an Experience Points app. Use the form at the end of this worksheet to identify your functions and plan your learning scenarios. Make one copy for each function.

Step 2: List all of your product’s functions.
These are the things that your product does. You don’t need to list every function, but make sure you list everything that is required to become a fully literate user. Each function will become the foundation of its own game-like learning scenario.

Step 3: Assign a category to each of your functions.

- **Startup Functions:** these are the functions that must occur before your product becomes operational— things like inserting a battery, plugging the product in, activating an account or connecting the product to a network.
- **Core Functions:** this is the most important thing your product does. There should only be one core function.
- **Essential Functions:** your core function won’t work properly without these functions.
- **Frequent Functions:** people use these functions regularly, like every month, every week or every day. This includes category popular functions that people want to use often, and maintenance functions that keep the product operational.
- **Advanced Functions:** other useful functions that are used less regularly than frequent functions. Don’t list every function of your product. Just the ones that are especially interesting or rewarding.

Step 4: List all of the necessary actions for each function.
Think of this a step-by-step instructions for an absolute beginner. List every step, even those you might usually take for granted. Try to avoid jargon. If you use an unusual word, highlight it so you remember to define it when you create your learning experience.

Step 5: Identify all of the dangers
These are the ways that the function can fail. Pay special attention to the core, essential and frequent functions.

Step 6: Describe the Consequences of Each Danger
What happens if the function fails in this way?

Step 7: Make a plan to prevent each danger
This is especially important for the core and essential functions. You want to minimize the chance of failure, so that users can practice the function without worrying about making mistakes.

Step 8: Reduce the consequences of each danger
This is also especially important for the core and essential functions. If users do fail, the consequences should be as painless as possible, and their recovery should be quick.

Step 9: Put the functions in order
Start with the core function. Then add the essential functions in the order of importance (or, if they are usually used in a specific order, put them in order of appearance instead). Then add the frequent functions (put them in order of importance or appearance too).
Now that your functions are in order, number them in the upper right hand corner of the form. When you design your learning experiences, you will introduce the functions in this order.

Make separate stacks for the startup functions and the advanced functions. They are special cases and you will handle them a little differently.

Step 10: Decide how you will reward the user when they learn this function.
Every time the user learns a function, they should be rewarded with a new tool and a new opportunity to use it. The new tool should be the next function on your list. The new opportunity will be your next learning scenario.
You may also want to give extra rewards, especially at important milestones (like the final essential function or the final frequent function).

Next steps
Now you are ready to develop your learning scenarios. Remember:

- Start with the core function. Exclude everything else.
- Expand the user's world one function at a time. Each function should get its own scenario.

Function		No.____
Category		
Actions		
Dangers	1- 2- 3- 4- 5-	
Consequences	1- 2- 3- 4- 5-	
Prevention	1- 2- 3- 4- 5-	
Recovery	1- 2- 3- 4- 5-	
Rewards		

APPENDIX B

IRB APPROVAL

Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	John Takamura AED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	02/08/2012
Committee Action:	**Exemption Granted**
IRB Action Date:	02/08/2012
IRB Protocol #:	1201007342
Study Title:	The Ludus: Using Gameplay to Enhance New Product Learning

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.